www.mtg.in | September 2019 | Pages 92 | ₹ 40

ZOOM in BIO
Human Brain and Spinal Cord

BIO GRAM

CHECK YOUR VITALS

MT BIOLOGY today

India's #1 MONTHLY FOR NEET

CONCEPT MAP

MONTHLY TEST DRIVE
CLASS XI-XII

CBSE warm-up!
CLASS XII

BIO Digest
CLASS XI-XII

mtG
Trust of more than 1 Crore Readers Since 1982

2019090012730

BIOLOGY OLYMPIAD PROBLEMS

Bridging Gap Between
You and Your **Success**
with **ALLEN**'s
DISTANCE
LEARNING PROGRAMME

JEE (Main+Advanced) | JEE (Main) | NEET (UG)/AIIMS
NTSE & Olympiads | Class 6th to 12th

- Study Material
- Joint Package
- Online Test Series
- Test Series
- Computer Based Test (CBT)
- ALLENtab

ALLEN™ CAREER INSTITUTE KOTA (RAJASTHAN) path to success

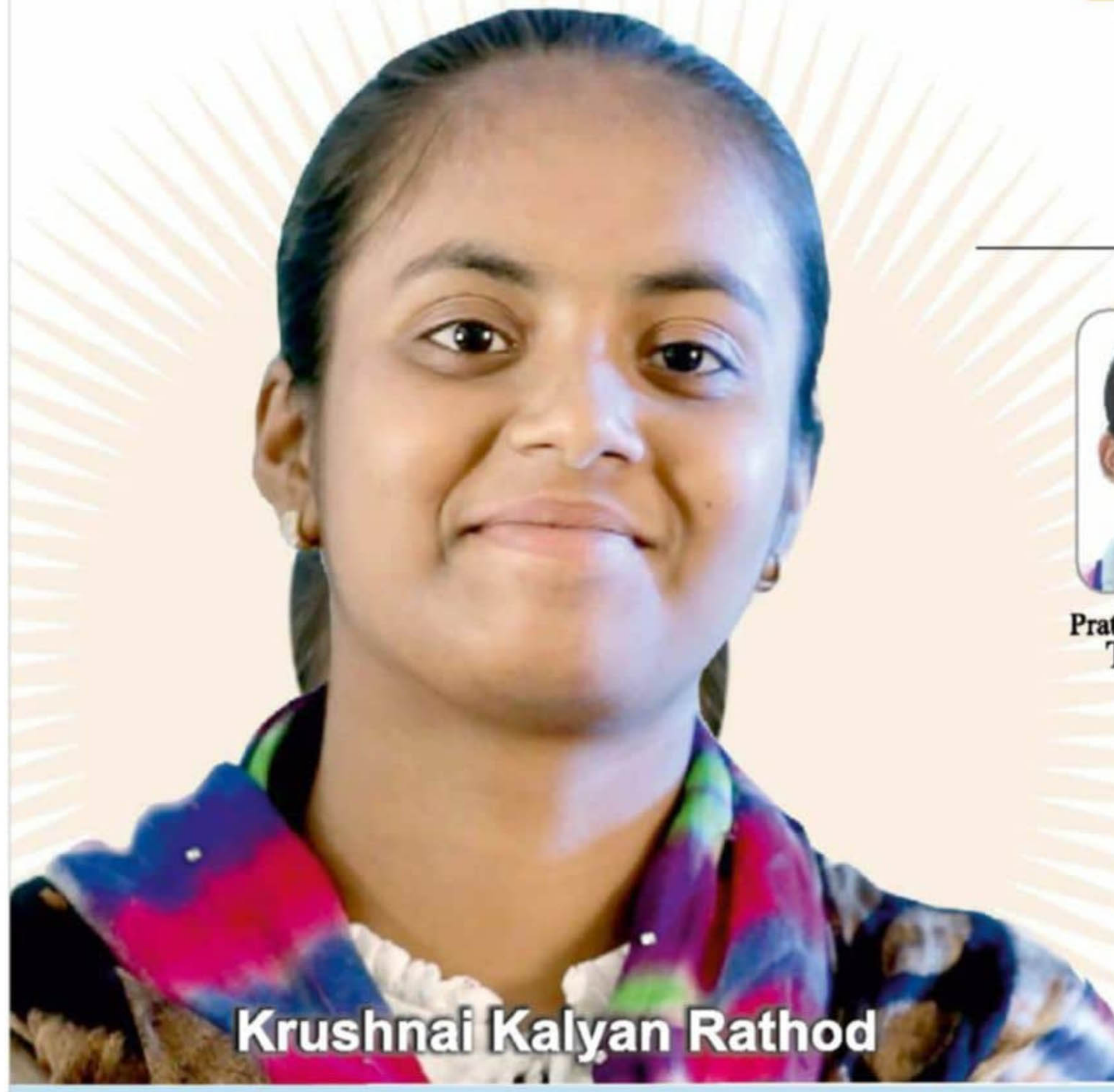
Corporate Office :
ALLEN CAREER INSTITUTE, "SANKALP", CP-6, IndraVihar, Kota (Rajasthan)-324005
DLP Helpline : +91-744- 2750275 **E-Mail :** dlp@allen.ac.in
Web: dlp.allen.ac.in | onlinetestseries.in | tab.allen.ac.in

ONCE AGAIN
IIB PROVED ITS
EXCELLENCE

Hearty Coagulations to all Successful Students for their **Bright Ascendency....**

In National Level Exam
NEET-2019
BIOLOGY

Krushnai K.Rathod Scored
BIOLOGY-350
NEET-676



Krushnai Kalyan Rathod

In MHT-CET 2019
Rucha O.Palkritwar
Stood 1st in State
(Among Girls)
NEET-645
BIO-330

• 'IIB' NEET TOPPERS •

Prathamesh Rokde
Total-675

Anant Malpani
Total-665

Vendant Patil
Total-654

Mahesh Kale
Total-654

Shounak Gaikwad
Total-651

Shivam Bhure
Total-650

Esha Kadam
Total-650

75 Students Scored more than 600 Marks in NEET-2019

700 Students Scored more than 300 Marks in Biology-NEET-2019

Till today **10,000+ IIB Students** have been selected for **MBBS** at **Medical Colleges all over INDIA.**

This Year IIBans have secured **1200+ MBBS SEATS** and the count is still rising....

IIB® THINK NEET | THINK IIB

EMPOWERING NATION THROUGH EDUCATION!
- Shyam Nagar, NANDED ▪ Udyog Bhavan, LATUR
CALL: 7304730730 | 7304567567
Visit us at : www.iibedu.com
email : info@iibnanded.com
https://www.facebook.com/IIBOffical/
https://www.youtube.com/channel/UC60K0L-M7FH47PCAwTVuwWQ

WEBSITE INSTAGRAM FACEBOOK YOUTUBE

mtG

www.mtg.in

#1 Bestseller

in NEET & AIIMS books

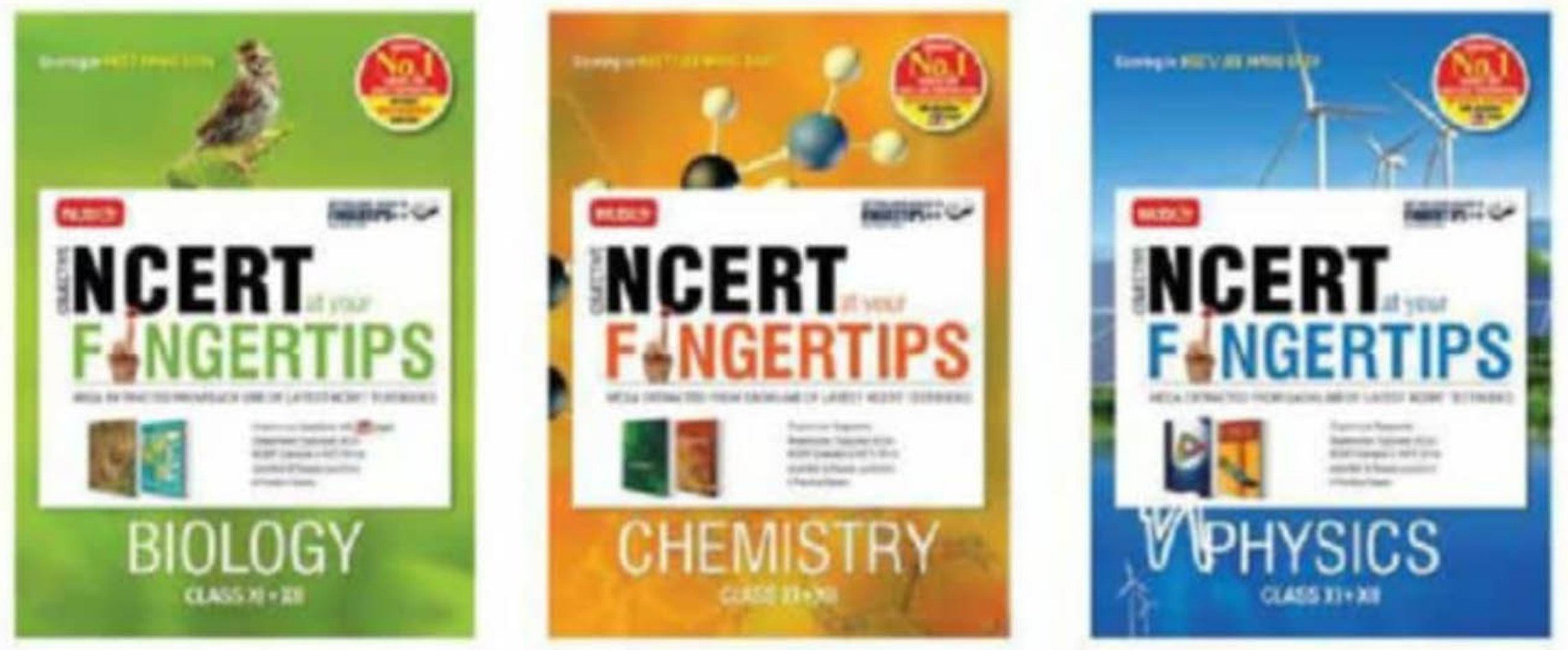
OBJECTIVE NCERT at your FINGERTIPS

BIOLOGY

Biology edition now available in full colour! See photos & illustrations come alive with unmatched details

For over 160 weeks now, MTG's Objective NCERT At Your Fingertips - Biology has stayed at the #1 spot on Amazon India's bestseller list of books for NEET & AIIMS exams. MTG is privileged to have earned its readers' trust and affection as being a #1 bestseller on India's leading e-commerce platform is no mean feat. MTG is proud of its editorial team which works hard to decode NCERT text into MCQs (Multiple Choice Questions), year after year, to create a great product that students and buyers rave about in their reviews.

Books from MTG Objective NCERT At Your Fingertips series on Amazon India's bestseller list:



Call 0124-6601200 or email info@MTG.in to learn more

NEET 2015
More than 70% same or similar MCQs

NEET 2016
More than 60% same or similar MCQs

NEET 2017
More than 60% same or similar MCQs

NEET 2018
More than 80% same or similar MCQs

NEET 2019
More than 80% same or similar MCQs

Trust MTG for getting it right,

year after year

Over the last 5 years, MTG has averaged a hit rate of 70% when it comes to curating the right content for your NEET preparation. Which means approx. 3 out of 4 questions in NEET were either exactly the same as, or similar to, questions in MTG's NEET books. The credit for this mind-blowing feat goes to MTG's skilled and experienced editorial team which painstakingly goes through volumes of NCERT subject matter that forms the basis for NEET, to create superior and relevant study material that has a high chance of success for its users. Proof lies in the pudding, right!

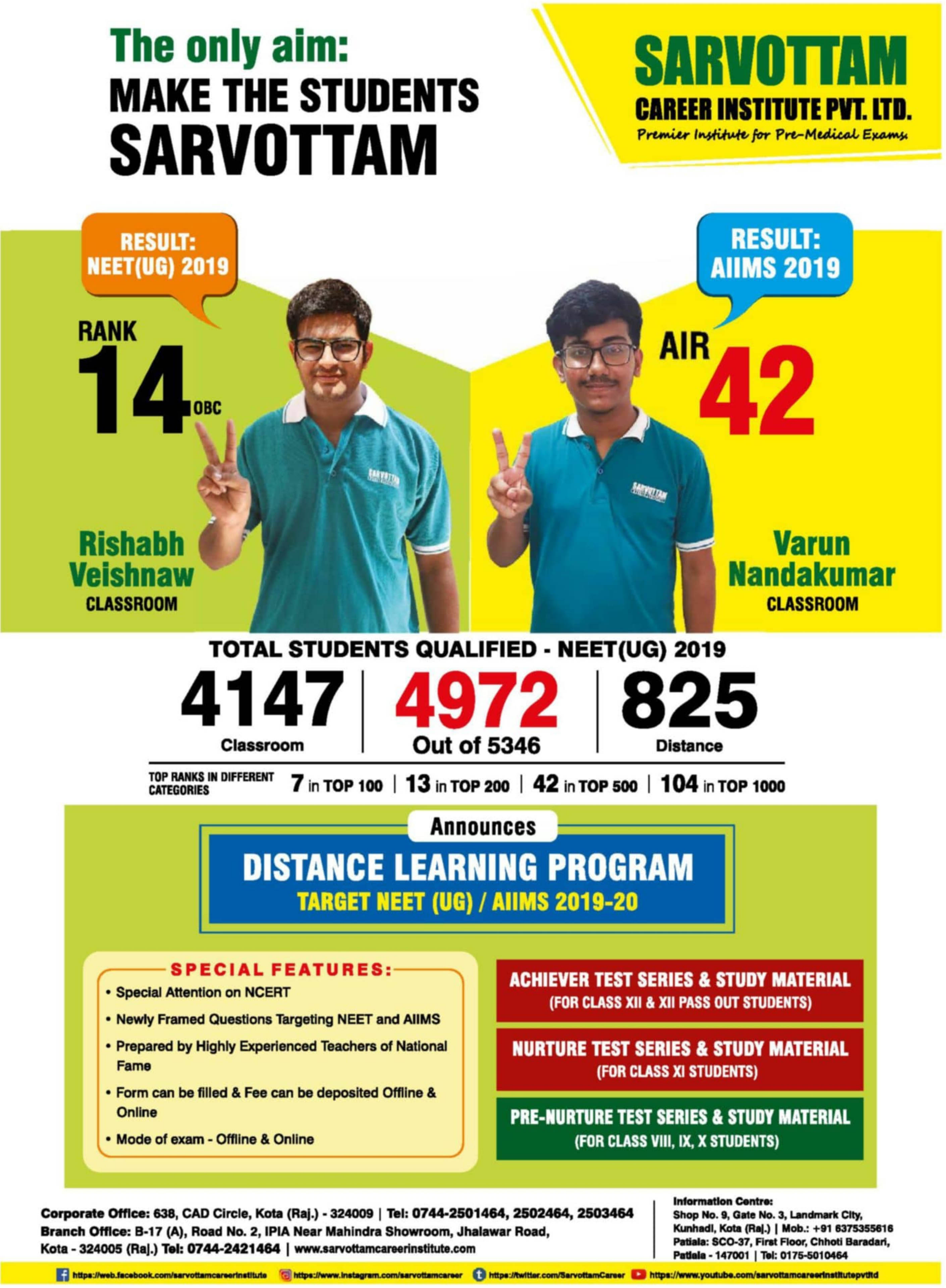
MTG's best-selling NEET books include

To find out which MTG NEET book is best-suited to your needs, call our NEET helpline toll-free at **1800-10-38673** today.
Or email **info@mtg.in** now. Visit bit.ly/mtg-neet to buy online.

Scan to buy on mtg.in

mtG

Scan to buy on Amazon.in


The only aim:
MAKE THE STUDENTS
SARVOTTAM

SARVOTTAM
CAREER INSTITUTE PVT. LTD.
Premier Institute for Pre-Medical Exams

RESULT: NEET(UG) 2019
RANK 14 OBC
Rishabh Veishnaw
CLASSROOM

RESULT: AIIMS 2019
AIR 42
Varun Nandakumar
CLASSROOM

TOTAL STUDENTS QUALIFIED - NEET(UG) 2019
4147 Classroom | 4972 Out of 5346 | 825 Distance

TOP RANKS IN DIFFERENT CATEGORIES: 7 in TOP 100 | 13 in TOP 200 | 42 in TOP 500 | 104 in TOP 1000

Announces
DISTANCE LEARNING PROGRAM
TARGET NEET (UG) / AIIMS 2019-20

SPECIAL FEATURES:
- Special Attention on NCERT
- Newly Framed Questions Targeting NEET and AIIMS
- Prepared by Highly Experienced Teachers of National Fame
- Form can be filled & Fee can be deposited Offline & Online
- Mode of exam - Offline & Online

ACHIEVER TEST SERIES & STUDY MATERIAL
(FOR CLASS XII & XII PASS OUT STUDENTS)

NURTURE TEST SERIES & STUDY MATERIAL
(FOR CLASS XI STUDENTS)

PRE-NURTURE TEST SERIES & STUDY MATERIAL
(FOR CLASS VIII, IX, X STUDENTS)

Corporate Office: 638, CAD Circle, Kota (Raj.) - 324009 | Tel: 0744-2501464, 2502464, 2503464
Branch Office: B-17 (A), Road No. 2, IPIA Near Mahindra Showroom, Jhalawar Road,
Kota - 324005 (Raj.) Tel: 0744-2421464 | www.sarvottamcareerinstitute.com

Information Centre:
Shop No. 9, Gate No. 3, Landmark City,
Kunhadi, Kota (Raj.) | Mob.: +91 6375355616
Patiala: SCO-37, First Floor, Chhoti Baradari,
Patiala - 147001 | Tel: 0175-5010464

https://web.facebook.com/sarvottamcareerinstitute https://www.instagram.com/sarvottamcareer https://twitter.com/SarvottamCareer https://www.youtube.com/sarvottamcareerinstitutepvtltd

MT
BIOLOGY today

Vol. XXI No. 9 September 2019

Corporate Office:
Plot 99, Sector 44 Institutional Area,
Gurugram -122 003 (HR), Tel : 0124-6601200
e-mail : info@mtg.in website : www.mtg.in

Regd. Office:
406, Taj Apartment, Near Safdarjung Hospital,
Ring Road, New Delhi - 110029.
Managing Editor : Mahabir Singh
Editor : Anil Ahlawat

CONTENTS

Class XI

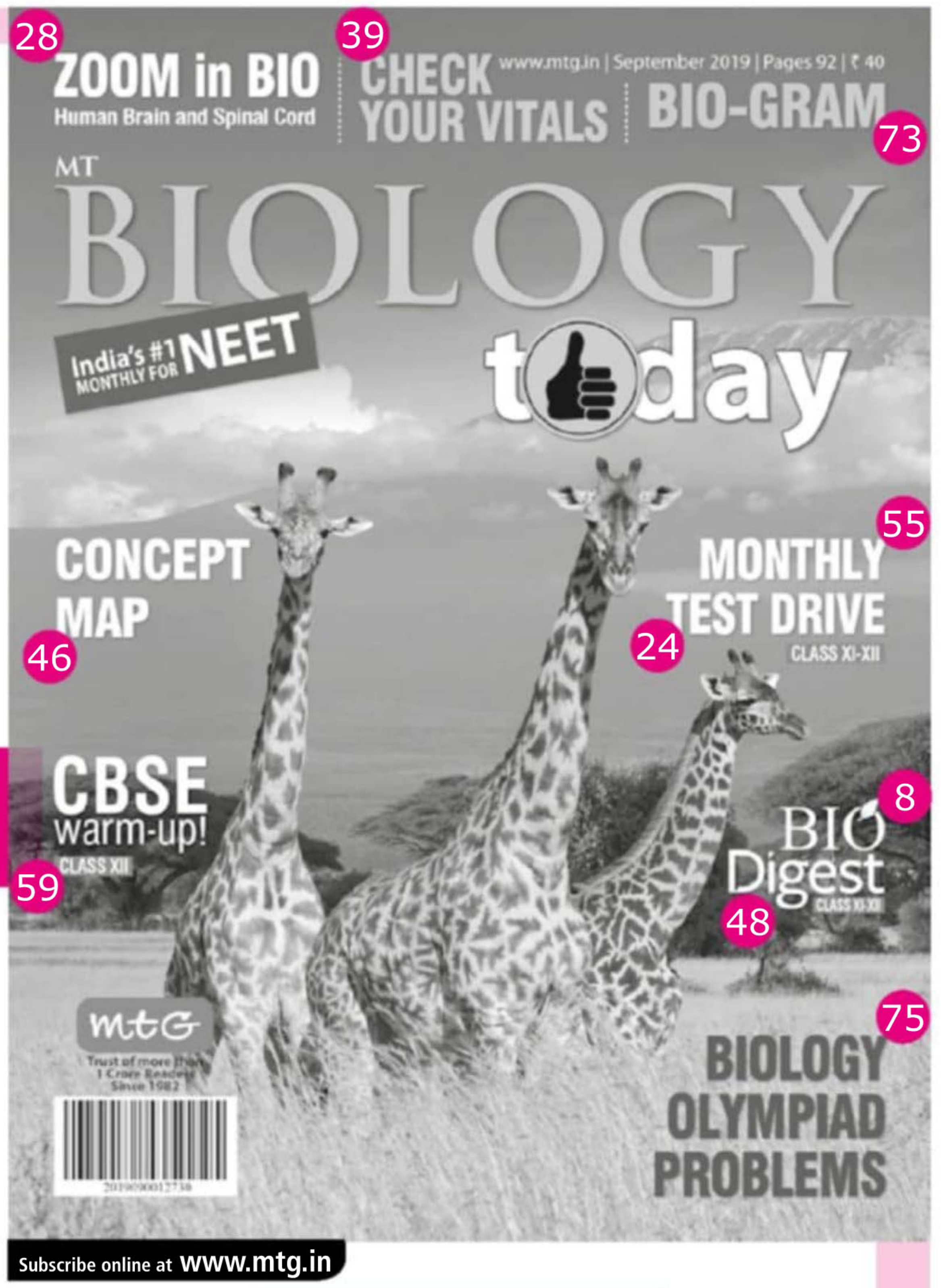
8 Bio Digest
Biomolecules &
Cell Cycle and Cell Division
24 Monthly Test Drive-4
28 Zoom in Bio
Human Brain and Spinal Cord
39 Check Your Vitals

Class XII

46 Concept Map
48 Bio Digest
Evolution
55 Monthly Test Drive-4
59 CBSE warm-up

Competition Edge

69 Field Note
70 You Ask We Answer
72 Word Grid
73 Bio-gram
74 Bioreporter
75 Biology Olympiad Problems
78 Scientist Express
79 Rapid Fire
81 Glance Around
83 Readers' Cafe
84 Made in China


28
ZOOM in BIO
Human Brain and Spinal Cord
39
CHECK YOUR VITALS
www.mtg.in | September 2019 | Pages 92 | ₹ 40
BIO-GRAM
73
MT BIOLOGY today
India's #1 MONTHLY FOR NEET
CONCEPT MAP
46
55
MONTHLY TEST DRIVE
24
CLASS XI-XII
CBSE warm-up!
CLASS XII
59
8
BIO Digest
48
CLASS XI-XII
mtG
Trust of more than 1 Crore Readers Since 1982
75
BIOLOGY OLYMPIAD PROBLEMS

Subscribe online at www.mtg.in

Individual Subscription Rates

	9 months	15 months	27 months
Mathematics Today	300	500	850
Chemistry Today	300	500	850
Physics For You	300	500	850
Biology Today	300	500	850

Combined Subscription Rates

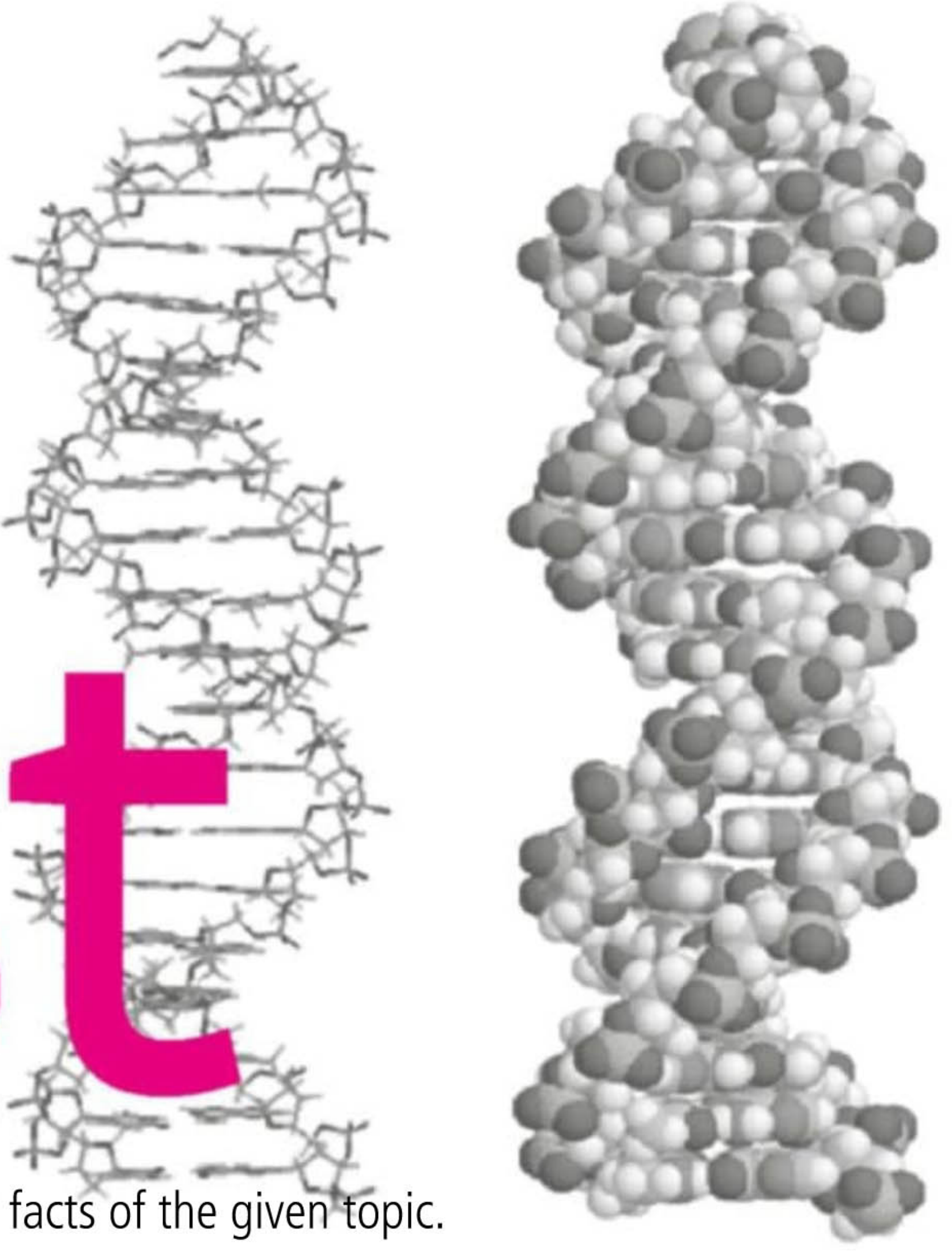
	9 months	15 months	27 months
PCM	900	1400	2500
PCB	900	1400	2500
PCMB	1200	1900	3400

Send D.D/M.O in favour of MTG Learning Media (P) Ltd.
Payments should be made directly to : MTG Learning Media (P) Ltd,
Plot 99, Sector 44 Institutional Area, Gurugram - 122 003, Haryana.
We have not appointed any subscription agent.

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat
Readers are adviced to make appropriate thorough enquiries before acting upon any advertisements published in this magazine. Focus/Infocus features are marketing incentives. MTG does not vouch or subscribe to the claims and representations made by advertisers. All disputes are subject to Delhi jurisdiction only.
Copyright© MTG Learning Media (P) Ltd.
All rights reserved. Reproduction in any form is prohibited.

Class XI

BIO Digest



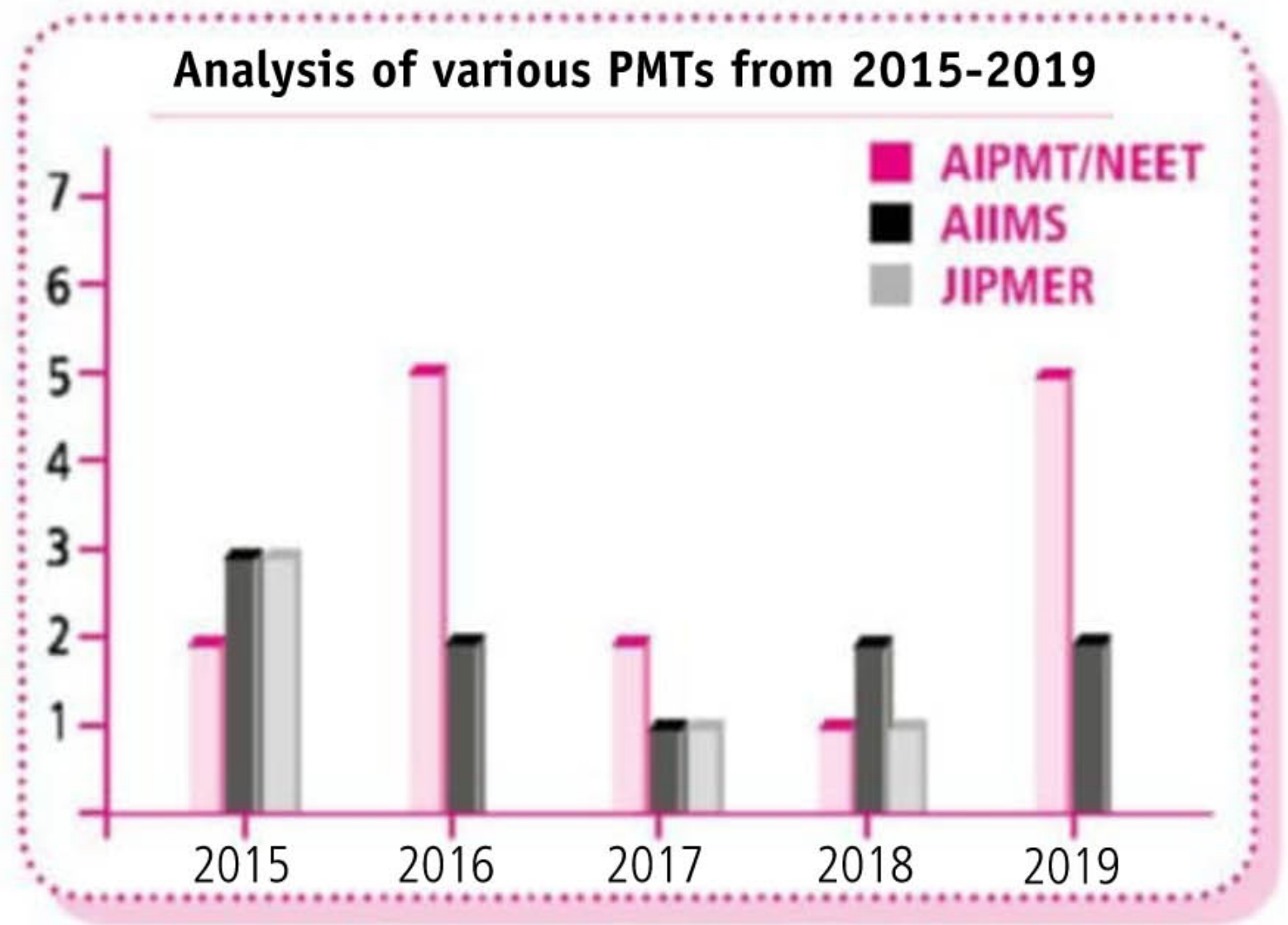
This article covers high yield facts of the given topic.

Biomolecules

- **Biological molecules** or **biomolecules** are chemical compounds produced by living organisms. These range from small molecules, such as metabolites to large molecules, such as proteins and carbohydrates.
- Based on the molecular weight and solubility, biomolecules are of two types:
  - **Micromolecules** are small sized, low molecular weight components that can be organic or inorganic. *E.g.*, water, minerals, amino acids, simple sugar, nucleotides, etc.
  - **Macromolecules** are large sized, complex structured, high molecular weight components. These include only organic polysaccharides, nucleic acids and proteins.

CARBOHYDRATES (SACCHARIDES)

- These are the most abundant organic molecules in nature having C, H and O, where H and O are present in the ratio of 2 : 1 as found in water (H_2O).
- They can be represented by the empirical formula $C_n(H_2O)_n$. Carbohydrates are also called saccharides because their basic components are sugars.
- In these molecules, the carbon atom forms chains or rings with two or more hydroxyl group and either an aldehyde or a ketone group, hence called **polyhydroxy aldehydes** and **ketones**.



- Based on the number of sugar units and the complexity, carbohydrates can be classified into following types:

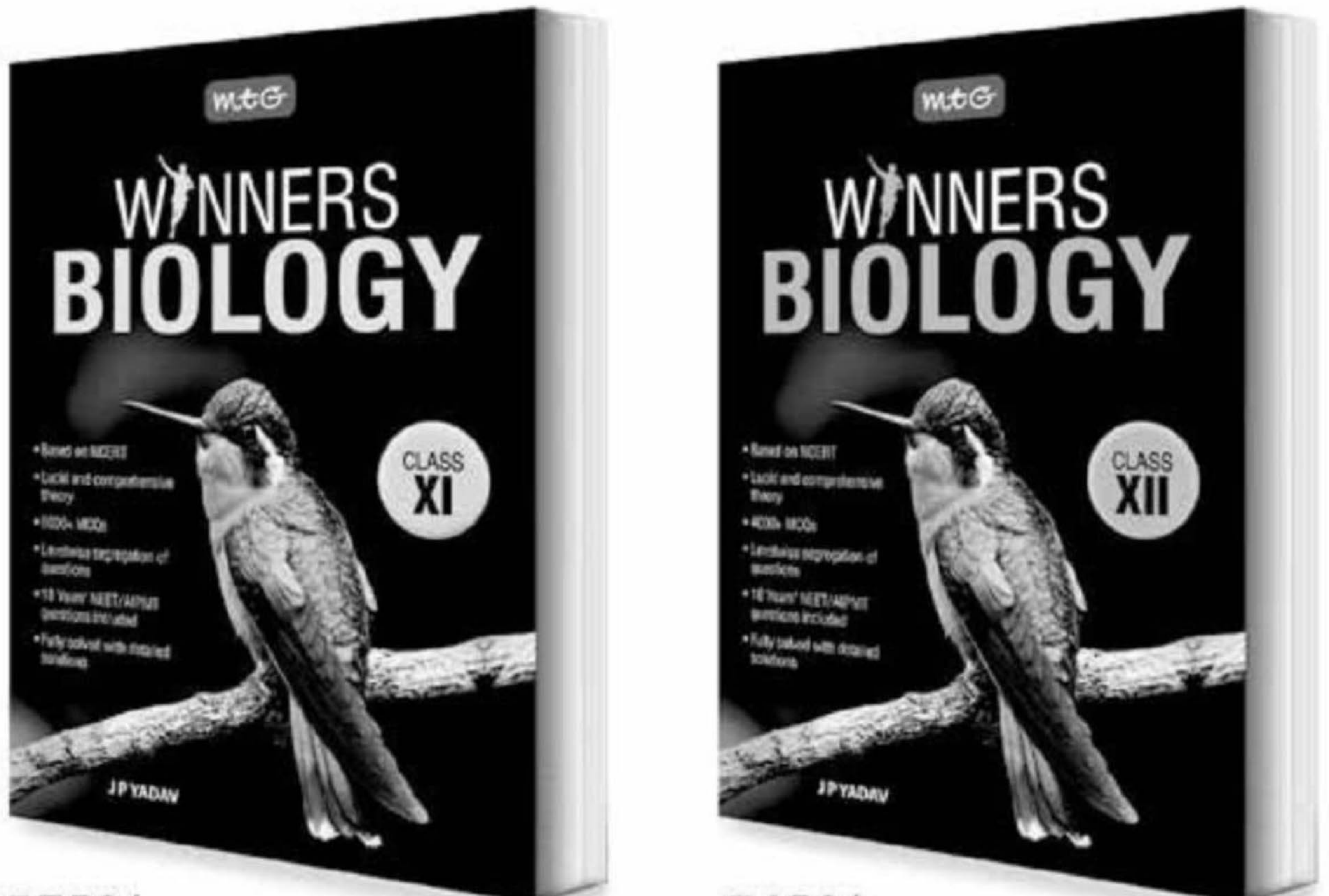
Monosaccharides

- They are the simplest carbohydrates which cannot be hydrolysed further into smaller carbohydrates. Depending upon the number of carbon atoms, monosaccharides can be classified as triose ($C_3H_6O_3$), tetrose ($C_4H_8O_4$), pentose ($C_5H_{10}O_5$), hexose ($C_6H_{12}O_6$), heptose ($C_7H_{14}O_7$), etc.
- They are linked by glycosidic bond (C–O–C or C–N–C) to form oligosaccharide or polysaccharide.
- Pentose and hexose are found in both forms: Open chain and ring. Hexoses are mainly white crystalline and sweet

mtG

Outperform in NEET
with
MTG Winners Biology

MTG Winners Biology for Class XI and Class XII is a perfect mentor for all students preparing for boards as well as competitive exams. It will strengthen your theory concepts and help you check your basics & your readiness with the question bank. Questions are framed on the latest NEET pattern and matching their difficulty level, they are segregated into 3 levels.



₹750/-   ₹450/-

KEY FEATURES
- Based on NCERT
- Lucid and comprehensive theory
- 10,000+ MCQs
- Levelwise segregation of questions
- 18 Years' NEET/AIPMT questions included
- Fully solved with detailed solutions

mtG Learning Media

Available at all leading book shops throughout India.
For more information or for help in placing your order:
Call 0124-6601200 or email info@mtg.in

Visit www.mtg.in for latest offers and to buy online!

in nature, *e.g.*, fructose is the sweetest of all naturally occurring sugars. It is also called fruit sugar. Glucose is the most important monosaccharide in living system and is also called as "grape sugar".

Oligosaccharides

- They are small carbohydrates formed by condensation of 2 to 9 monosaccharides.
- Based on the number of monosaccharide molecules condensed to form oligosaccharides, they are classified as follows:

– **Disaccharides :** The smallest and the commonest oligosaccharides are disaccharides. They are formed by the condensation of 2 molecules of monosaccharides. Example: lactose, sucrose and maltose, etc.

> **Lactose** or **milk sugar** is a **reducing sugar** which is formed by **β 1 $\rightarrow$ 4 condensation** of one **glucose** and one **galactose molecule**.
>
> **Sucrose,** the commercial sugar or **cane sugar** is obtained from sugarcane (*Saccharum officinarum*). It is formed by condensation of one molecule each of **glucose** and **fructose**. Glycosidic bond is formed between carbon 1 of glucose and carbon 2 of fructose **(α 1 $\rightarrow$ 2 linkage)**. Sucrose is a **non-reducing sugar**.
>
> **Maltose** a reducing sugar is found in most germinating seeds. It is formed by condensation of two molecules of glucose having **(α 1 $\rightarrow$ 4)** glycosidic bond.

– **Trisaccharides :** They are formed by the condensation of 3 molecules of monosaccharides (*e.g.*, raffinose).

– **Tetrasaccharides :** They are formed by the condensation of 4 molecules of monosaccharides (*e.g.*, stachyose).

– **Pentasaccharides :** They are formed by the condensation of 5 molecules of monosaccharides and so on.

- Oligosaccharides are important for cell recognition, cell attachment and act as receptor molecules.

Table: **Differences between reducing and non-reducing sugars**

	Reducing sugars	Non-reducing sugars
(i)	The sugars have a free aldehyde (–CHO) or ketone (–CO) group.	A free aldehyde or ketone group is absent.
(ii)	The sugars can reduce cupric ions (Cu^{2+}) of Benedict's or Fehling's solution to cuprous ions (Cu^{+}), during which blue colour of copper sulphate changes to brick red.	They do not reduce cupric ions of Benedict's or Fehling's solution to cuprous ions.

Polysaccharides

- They are complex carbohydrates, formed by polymerisation of more than 10 monosaccharide monomers. They are also called **glycans**. They are long chained that may be branched or unbranched.
- On the basis of the composition, polysaccharides are of two types:

– **Homopolysaccharides :** Homoglycan are complex carbohydrates formed by polymerisation of only one type of monosaccharide monomers. *E.g.*, glucan, fructan, xylan, etc.

– **Heteropolysaccharides :** Heteroglycans are complex carbohydrates produced by condensation of two or more types of monosaccharides or their derivatives. *E.g.,* agar, chitin peptidoglycan, etc.

- On the basis of functions polysaccharides are of following types :

Storage polysaccharides

- Some homopolysaccharides are stored in form of fuel which serve as reserve food. When needed, storage polysaccharides are hydrolysed. The main storage polysaccharides are as follows :

– **Starch :** Starch consists of two components, amylose and amylopectin. Both of these are formed by condensation of α-D-glucose. In amylose, the successive glucose units (100-200) are linked by 1-4α-linkages that is in the form of continuous straight chain but arranged helically. Amylopectin contains larger number of glucose units in a straight chain which bears several side chains.

– **Glycogen :** It is the polysaccharide food reserve of animals, bacteria and fungi. It is popularly called animal starch. Chemically, it is similar to starch. It has about 30,000 glucose residues joined together by $\alpha(1 \rightarrow 4)$ **glycosidic bonds** and $\alpha(1 \rightarrow 6)$ **glycosidic bonds at branching points**.

– **Inulin :** It is a fructan storage polysaccharide of roots and tubers of *Dahlia* and related plants. Inulin is not metabolised in human body and is readily filtered through the kidney.

Structural polysaccharides

- These polysaccharides make the structural framework of the cell wall in plants and skeleton of some animals.

– **Chitin :** It is the second most abundant organic substance. Chitin is a complex heteropolysaccharide which is found as the structural component of fungal walls and exoskeleton of arthropods. In chitin, monomer unit is a nitrogen containing glucose derivative known as **N-acetyl glucosamine**. It has an unbranched configuration and monomers are joined together by **1-4 β-linkages**.

– **Cellulose :** It is a fibrous, tough, water insoluble substance found in the cell wall of plants, some fungi and protists. Cellulose is a homopolysaccharide composed of **glucose units** linked by β **(1 $\rightarrow$ 4) glycosidic bonds**. Cellulose molecules have **unbranched and linear chains.**

Mucopolysaccharides

- They are slimy substances which possess acidic or aminated polysaccharides formed from galactose, mannose, sugar derivatives and uronic acids. Mucopolysaccharides are found in both plants and animals. They may be attached to a protein molecule to form a proteoglycan. **Proteoglycans** provide the ground or packing substance of connective tissue. *E.g.*, hyaluronic acid, chondroitin sulfate and heparin.

– **Mucoproteins (glycoproteins) :** The protein with conjugated mucosaccharides form mucus. These are found in stomach, nasal secretion, intestine, vagina and are antibacterial and protective in function.

LIPIDS

- Lipids are **fatty acid esters of alcohols** and related substances which are insoluble in water but get dissolved in a number of nonpolar organic solvents like ether, benzene, chloroform, acetone, etc. They may also form colloidal complex that get dispersed uniformly in water in the form of minute droplets. Such complex is called **emulsion**.
- Lipids are basically made of carbon, hydrogen and sometimes oxygen. The content of oxygen is always small as compared to hydrogen and carbon. They occur mainly in natural fats and oils. The basic components of all lipids are fatty acid.
- On the basis of the nature of hydrocarbon chain, fatty acids are of following types:

– **Unsaturated fatty acids :** The carbon chain contains one or more double bonds with unsaturated C atoms. Its general formula is $C_nH_{2n-2x}O_2$. *E.g.*, oleic acid $C_{18}H_{34}O_2$ (with one double bond), linolenic acid $C_{18}H_{30}O_2$ (with three double bonds). Unsaturated fatty acids have lower melting point than the saturated fatty acids. Most plant lipids have unsaturated fatty acids.

– **Saturated fatty acids :** The carbon chain lacks double bond and C atoms are fully saturated. General formula is $C_nH_{2n}O_2$ *e.g.*, palmitic acid ($C_{16}H_{32}O_2$) and stearic acid ($C_{18}H_{36}O_2$). Most animal lipids have saturated fatty acids.

- Lipids are classified into three types : simple, compound and derived.

Simple Lipids

- They are formed from fatty acids and alcohol. They do not have any additional group, *e.g.*, fats and wax.

(i) **True fat :** They are **triglycerides**, formed by esterification of 3 molecules of fatty acids and 1 molecule of glycerol.

- **Pure fats -** Fats with three similar fatty acids, *e.g.*, tripalmitin, tristearin.
- **Mixed fats -** Fats having different fatty acids, *e.g.*, butter.
- **Oils -** Fats which are liquid at room temperature. They form hard fats on hydrogenation, *e.g.*, groundnut oil, sesame oil, mustard oil.
- **Hard fats -** Fats that are solid at room temperature of about 20°C. They contain long chain saturated fatty acids, *e.g.*, animal fat.

(ii) **Waxes :** They are fatty acid esters of long chain monohydric alcohols like cytyl, ceryl or mericyl. *E.g.*, Beewax. Tuberculosis and leprosy bacteria produce a wax called **wax-D** which is a major factor in their pathogenicity. **Paraffin wax** is obtained from petroleum.

(iii) **Cutin:** It is a complex lipid produced by cross-esterification and polymerisation of hydroxy fatty acids as well as other fatty acids with or without esterification by alcohols other than glycerol.

(iv) **Suberin:** It is a mixture of fatty material having condensation products of glycerol and phellonic acid or its derivatives.

Compound Lipids

- These are esters of fatty acids with alcohol, containing some other groups also. They are of 3 types:

(i) **Phospholipids :** These are composed of **a molecule of glycerol or other alcohol** having a **phosphate group** joined to one of its outer –OH groups. **A Nitrogen-containing base** is bound to this phosphate group. **Two fatty acid molecules** are linked to other two –OH groups. The phospholipid molecule has a **nonpolar** and **hydrophobic "tail"** consisting of fatty acid chains and a **polar and hydrophilic "head"** comprising a negatively charged phosphate group and a positively charged base.

(ii) **Lipoproteins:** These consist of **lipids** (mainly phospholipids) **and proteins**. They are main constituent of membranes and also occur in the milk and egg yolk. Lipids are transported in the blood plasma and lymph as lipoproteins. There are five types of lipoproteins, namely **chylomicrons, very low density lipoproteins (VLDL), low density lipoproteins (LDL), high density lipoproteins (HDL) and free fatty acid-albumin complex**.

(iii) **Glycolipids:** They consist of a fatty acid, an amino alcohol sphingosine and a sugar residue. The brain and neurons are rich in glycolipids which help in nerve conduction and myelin formation.

Derived Lipids

- These are lipid like substances and are derivatives of lipid, *e.g.*, steroids, terpenes and prostaglandins.

(i) **Steroids :** They are a group of complex lipids that contains a hydrogenated cyclopentano-perhydrophenanthrene ring system. The steroids do not contain fatty acids but are included in the lipids because they have fat-like properties.

Cholesterol : It is the most common sterol in the animals, human tissues. It is present in food, especially that is rich in animal fats and is also synthesised in liver. Its formula is $C_{27}H_{45}OH$. Cholesterol and its esters are **insoluble in water,** hence their deposition on the lining of the blood vessels leads to high blood pressure and many heart diseases.

(ii) **Terpenes :** They are lipid like hydrocarbons formed of **isoprene** (C_5H_8) units. These are major component of essential oils produced by certain plants. Natural rubber and carotenoids are terpenoid compounds.

(iii) **Prostaglandins :** They are hormone like compounds derived from the 20-carbon polyunsaturated fatty acid and arachidonic acid. The prostaglandins have a variety of effects such as vasodilation, vasoconstriction, stimulation of intestinal smooth muscle, etc.

INTEXT PRACTICE QUESTIONS

1. **How does reducing sugar differ from non-reducing sugar on the basis of structure?**
2. **What is the general formula of lipid?**

AMINO ACIDS

- They are the building blocks of proteins. Amino acids are organic acids (with carboxylic group –COOH) having amino group ($–NH_2$) generally attached to α-carbon or carbon next to the carboxylic group. The α-carbon also bears a variable hydrocarbon or alkyl group R and hydrogen.
- There are 20 amino acids that are normal components of cell proteins. These are called **protein amino acids**.
- Many amino acids found in cells do not form proteins. These are called **non-protein amino acids**. Among these are ornithine, citrulline, gamma-aminobutyric acid (GABA).
- On the basis of properties of the groups, amino acids are **neutral** (*e.g.*, alanine, glycine), **acidic** (*e.g.*, aspartic acid, glutamate), **alcoholic** (*e.g.*, serine), **basic** (*e.g.*,lysine), **heterocyclic** (*e.g.*, proline), **sulphur containing** (*e.g.*, cysteine) and **aromatic** (*e.g.*, phenylalanine).
- Plants can synthesise all the protein amino acids they require but animals are unable to manufacture all of their own amino acids from raw materials. For this they are dependent upon the plants. However, animals can form several amino acids through transformation or transamination. The amino acids which cannot be synthesised by animals through transformation or transamination are called **essential amino acids**. These are 7 in number and must be present in their diet, *viz.*, leucine, isoleucine, valine, tryptophan, phenylalanine, lysine and methionine.
- The amino acids that can be synthesised by human body from raw materials are called **non-essential amino acids**. They are 13 in number and need not to be present in the diet.
- **Peptide Formation**-Amino acids condense to form peptides by linking the successive amino acids through peptide bond. Peptide bond (–NH–CO–) is formed between two amino acids by elimination of a water molecule.

Functions of Amino Acids

- They are building blocks of proteins, enzymes and participate in biosynthetic pathways. They are the components of antibiotics. Amino acids also serve an important role in gluconeogenesis.
- Amino acid **glycine** provides nitrogen and carbon atoms for the synthesis of protoporphyrin and heme and **tryptophan** produces plant hormone indole 3-acetic acid (IAA).
- Amino acid **tyrosine** gives rise to two hormones (thyroxine and adrenaline) and skin pigment melanin.
- **Histamine** is derived from amino acid histidine through decarboxylation. It is required for optimum functioning of muscles, blood capillaries and gastric secretion.

PROTEINS

- Proteins are linear, unbranched polymers of amino acids (linked together by peptide bond). They are large-sized, heteropolymeric macromolecules having one or more chains of amino acids or (polypeptide). Being macromolecules, proteins are not freely soluble in water but form colloidal complex with the same. Chemically, a protein is made of carbon, hydrogen, oxygen, nitrogen and sulphur. Some proteins additionally contain phosphorus, iron and other elements. **Collagen** is the most abundant protein of animal world and **RuBisCo** is the most abundant protein in plants.

Structure of Protein

- Every protein has a three-dimensional structure that corresponds to its functions. The four level structural organisation in proteins are primary, secondary, tertiary and quaternary.

WHO AM I ...

"I am the second most abundant organic substance and a complex heteropolysaccharide."

...search me ☺

Primary Structure

It is the linear sequence of amino acids in a polypeptide chain. Primary structure describe the basic structure of a protein *i.e.*, number and sequence of amino acids in each polypeptide constituting the protein.

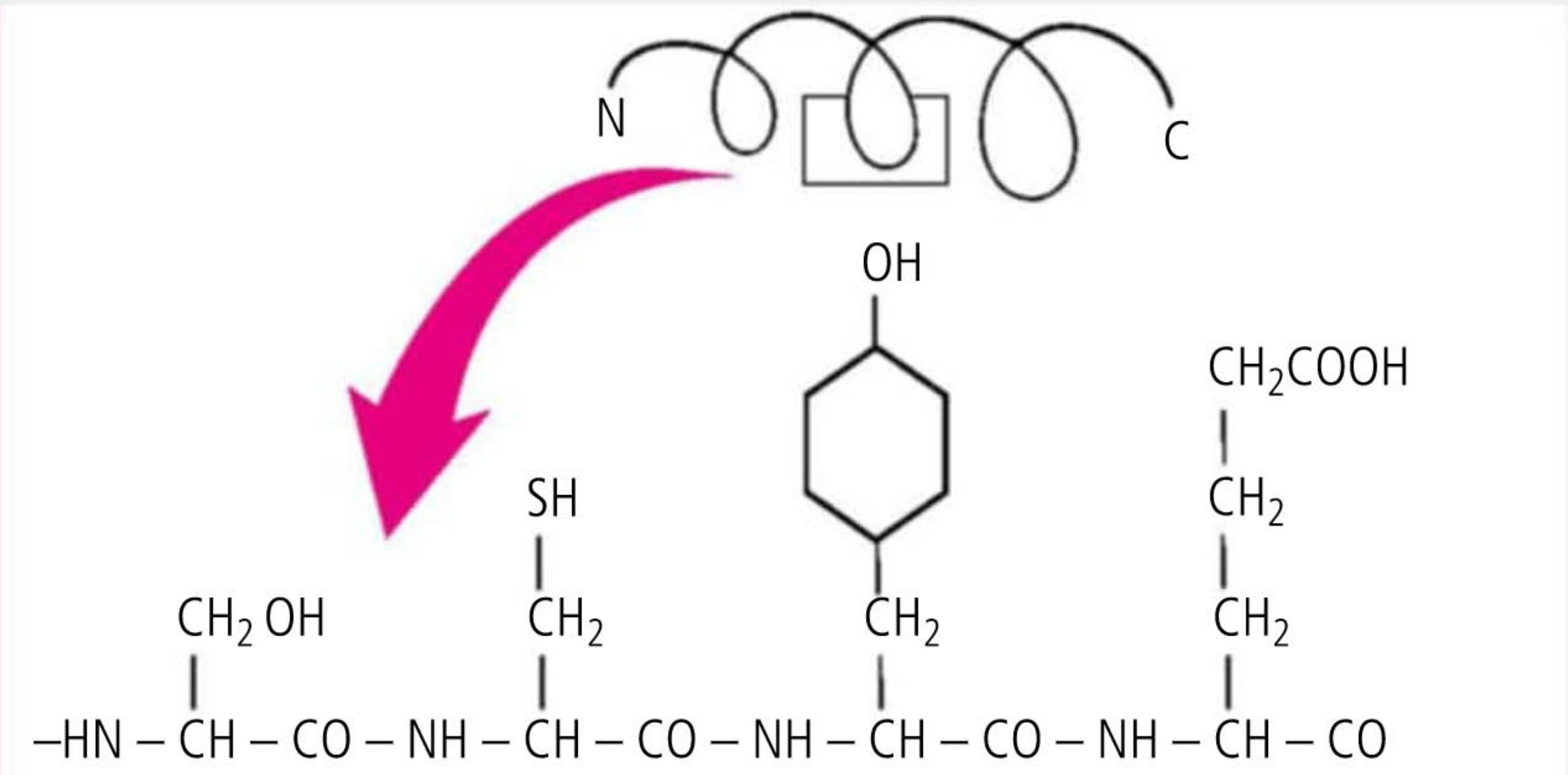


Fig.: Primary structure of a protein. N and C represent its first and last termini

Secondary Structure

It is the development of new stearic relationships of amino acids present in the linear sequence inside the polypeptides. Secondary structures depend on **hydrogen bonds** between – C = O group of one amino acid and –NH groups of next fourth amino acid. There are 3 types of secondary structures.

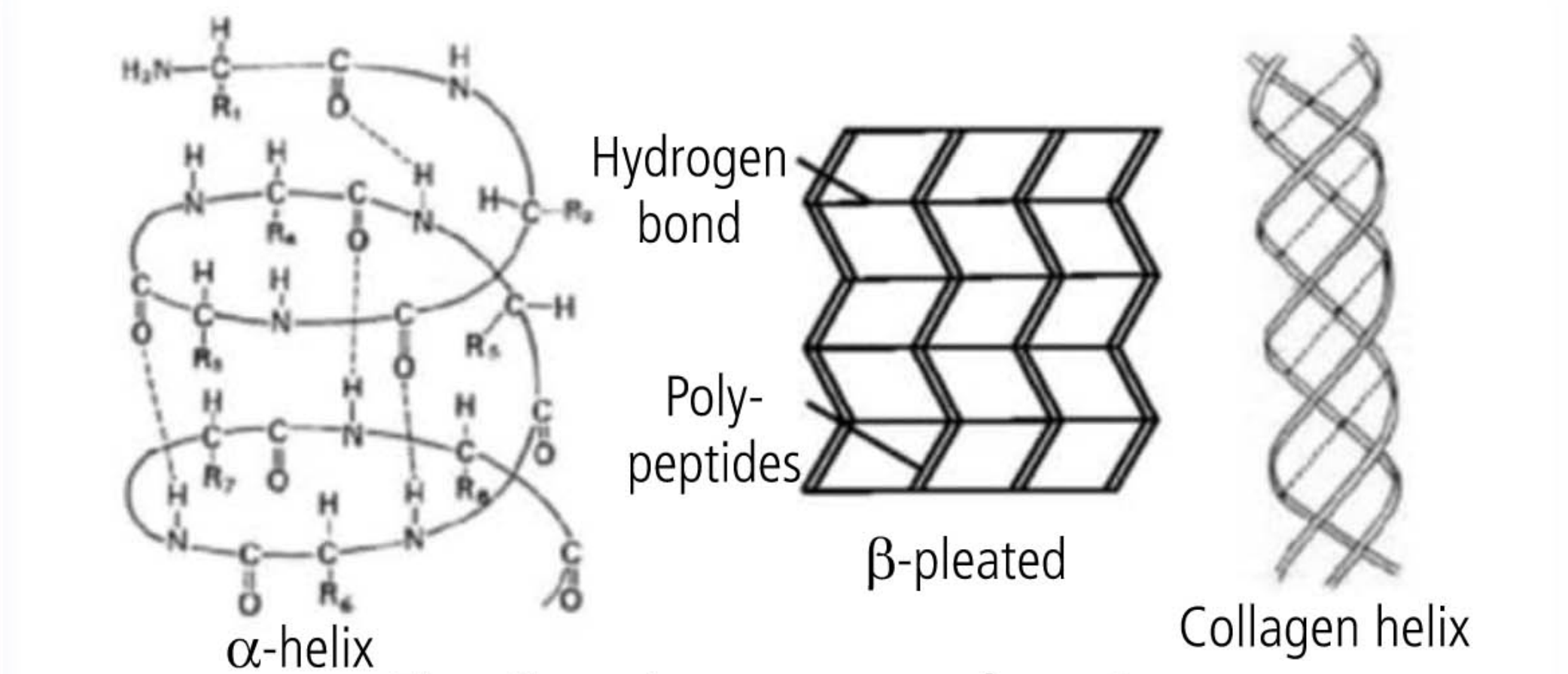


Fig.: Secondary structures of proteins

Tertiary Structure

It is formed by the further complex bending and folding of secondary structure to form various types like sphere, rod or fibre. Tertiary structure is stabilised by several types of bonds – hydrogen bonds, ionic bonds, disulphide bonds, hydrophobic bonds, vander Waals interactions, etc. This structure imparts a 3-D conformation to the protein.

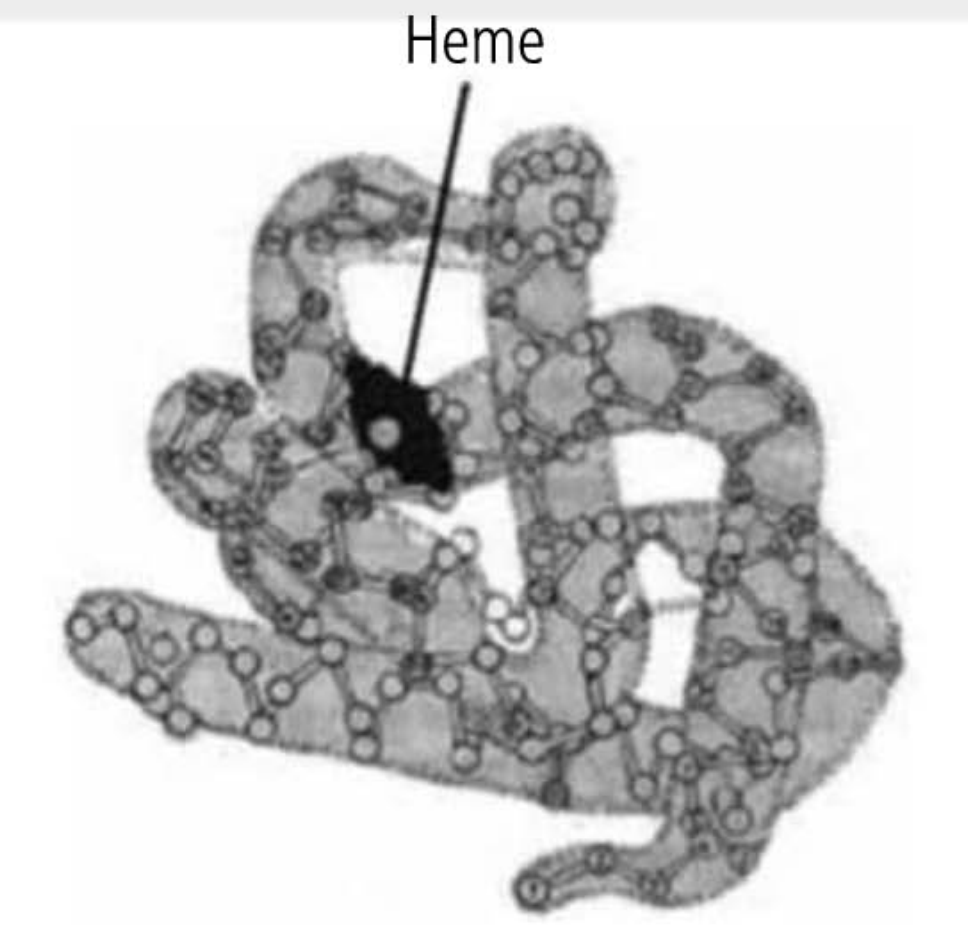


Fig.: Tertiary structure of protein myoglobin

Quaternary Structure

It is found only in multimeric proteins and consist of two or more polypeptide chains. Each polypeptide develops its own tertiary structure and functions as subunit of protein, *e.g.*, insulin, collagen, haemoglobin, etc.

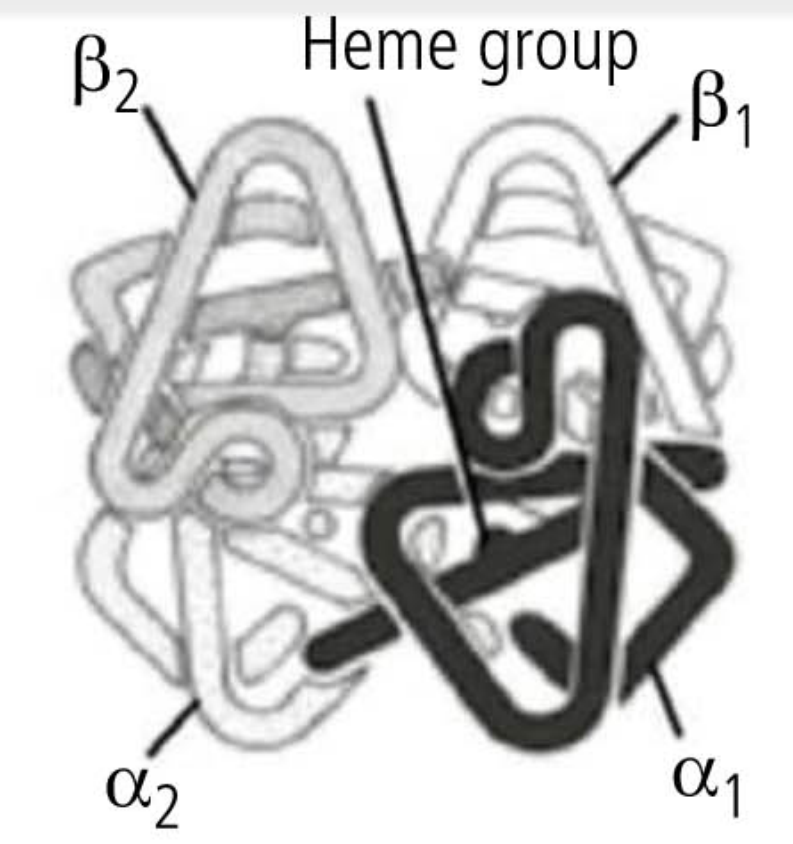


Fig.: Quaternary structure of haemoglobin showing four polypeptide chains— two α-chains and two β-chains

- Based on the composition, proteins can be classified as simple protein (*e.g.*, histones, keratin), conjugated proteins (*e.g.*, nucleoprotein, glycoprotein) and derived protein (*e.g.*, proteoses, fibrin).
- On the basis of shape, proteins can be fibrous, *i.e.*, thread like, occur singly or in groups (*e.g.*, keratin, myosin) and globular *i.e.*, rounded in outline (*e.g.*, egg albumin, histones).

Functions of Proteins

- Blood plasma protein, ***e.g.***, globulin helps in the transport of important nutrients. Haemoglobin of RBCs transport oxygen from lungs to different parts of the body. Myoglobin of muscles stores oxygen.
- Immunoglobulins, are plasma proteins formed in response to antigen stimulation. These recognise and neutralise foreign proteins, toxins and other pathogens. Interferon, a cellular protein is effective in treating viral infection.
- Contractile system of muscles is made up of actin and myosin proteins.
- Catalyse chemical reactions that occur in living world, ***e.g.***, pepsin, trypsin, flavoprotein, etc.
- Fibrinogen and thrombin present in blood plasma, help in clotting of blood.
- Keratin forms protective structures of animals like nails, hooves, hair, feathers, etc.

NUCLEOTIDES

- These are the basic units of nucleic acids (DNA and RNA). Nucleotides consist of carbon, hydrogen, oxygen, nitrogen and phosphorus.

Composition of Nucleotides

- Each nucleotide consists of three distinct units: a phosphate group, pentose sugar and a nitrogenous base. The base-sugar combination without phosphate group is called a **nucleoside**.

- The nitrogenous bases are heterocyclic compounds found in nucleotides. They may be either a single ringed **pyrimidine** or a double ringed **purine**. A **pyrimidine** molecule is smaller and has one 6-membered ring, with nitrogen at 1 and 3 positions. A **purine** molecule is larger and has two rings, a 6-membered ring joined to a 5-membered ring. These rings are joined at 4 and 5 positions. The 5 membered ring carries nitrogen at 7 and 9 positions while the 6 membered ring carries nitrogen at 1 and 3 positions.
- In nucleotides, pentose sugars are of two types : Ribose ($C_5H_{10}O_5$) and deoxyribose ($C_5H_{10}O_4$). Both sugars are present in furanose form. Deoxyribose sugar (oxygen absent at 2 Carbon) occurs only in DNA while ribose sugar occurs in RNA and biologically active nucleotides such as AMP, ADP, ATP, etc.
- Nucleotides are phosphate esters of nucleosides. A nucleotide may have 1, 2 or 3 phosphate groups. But in nucleic acid composition only nucleotides with one phosphate group are involved.
- **Adenosine triphosphate (ATP) :** It is the principal energy carrying molecules of all cells composed of adenine, ribose sugar and phosphoric acid. There are two additional phosphate groups that make it a **high energy molecule**.

NUCLEIC ACIDS

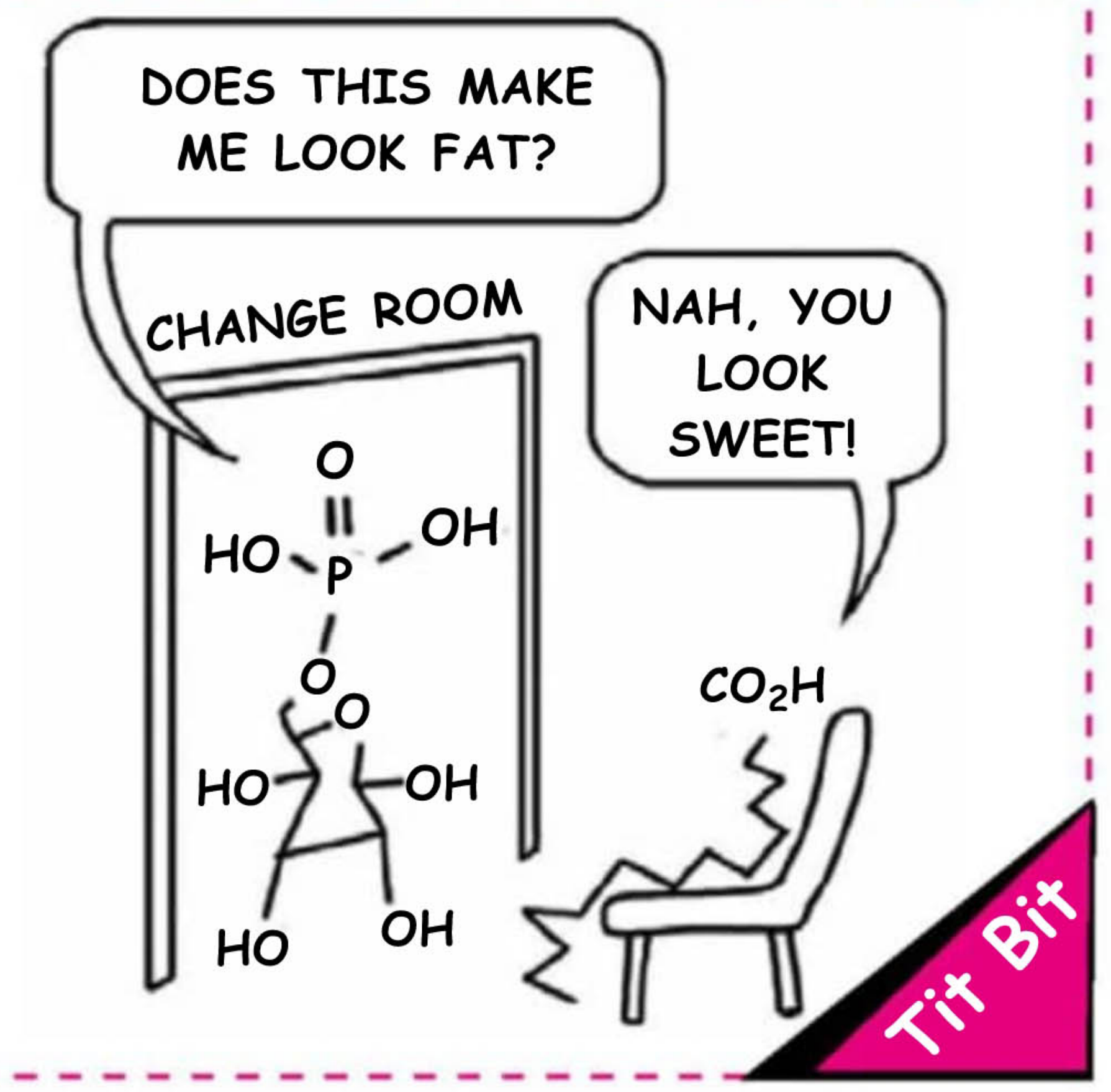
- These are the polymers of the nucleotides, hence called polynucleotide. They contain genetic information that determine all the heritable characteristics of a living organism. They show a wide variety of secondary structures.
- The two types of nucleic acids are:
  (i) Deoxyribonucleic acid (DNA)
  (ii) Ribonucleic acid (RNA)

DNA

- DNA is the largest macromolecule. It is a polymer of **deoxyribonucleotides**. It is composed of monomeric units namely deoxyadenylate (dAMP), deoxyguanylate (dGMP), deoxycytidylate (dCMP) and deoxythymidylate (dTMP). DNA does not contain uracil. The monomeric deoxynucleotides in DNA are held together by **3′, 5′-phosphodiester bridges.** It constitutes the genetic material of all organisms with the exception of riboviruses.
- Various forms of DNA are B-DNA, Z-DNA, A-DNA, C-DNA and D-DNA.

Double Helix Structure of B-DNA

- The double helical structure of DNA was proposed by **James Watson** and **Francis Crick** in 1953 (Nobel prize, 1962).
- The key points of double helical structure of DNA are-
  (i) DNA molecules consist of two polypeptide chains helically coiled around a common axis to form a right handed double helix.
  (ii) The two strands are antiparallel, *i.e.,* they run in opposite directions. One strand runs in the 5′ to 3′ direction while the other in 3′ to 5′ direction.
  (iii) The **width** (or diameter) of a double helix is **20** Å (2 nm). Each turn **(pitch)** of the helix is **34** Å (3.4 nm) with **10 pairs** of nucleotides, each pair placed at a distance of about **3.4** Å (0.34 nm).
  (iv) Each strand of DNA has a **hydrophilic deoxyribose phosphate backbone** (3′ – 5′ phosphodiester bonds) on the outside (periphery) while the **hydrophobic bases are stacked inside** (core).
  (v) The two strands are held together by **hydrogen bonds** formed by **complementary base pairs**. There are 2 hydrogen bonds between adenine and thymine (A = T) and 3 hydrogen bonds between cytosine and guanine (C ≡ G).
  (vi) Both the strands are complementary with each other.
  (vii) The double helix has **major grooves** and **minor grooves** along the phosphodiester backbone.



Tit Bit

Chargaff's Rules

- The purines and pyrimidines are always present in equal amounts *i.e.,* **A + G = T + C.**
- The base ratio A + T / G + C may vary from one species to another, but is constant for a given species. This ratio can be used to identify the source of DNA and can help in classification.
- The deoxyribose sugar and phosphate components occur in equimolar proportions.
- The amount of adenine is always equal to that of thymine, and the amount of guanine is always equal to that of cytosine, *i.e.,* **A = T** and **G = C.**

Functions of DNA

(i) DNA is the genetic material which carries all the hereditary information coded in the arrangement of its nitrogen bases.
(ii) By replication it passes genetic information from one cell to its daughters or from one generation to the next.
(iii) Crossing over of DNA produces recombinants.
(iv) Changes in sequence and number of nucleotides in DNA produce mutations which in turn causes variations and formation of new species.
(v) DNA controls the metabolic reactions of cells through RNAs and RNA-directed synthesis of proteins, enzymes and other biochemicals.

RNA

- It is a polymer of **ribonucleotides**, held together by **phosphodiester bridges**. It is generally involved in protein synthesis and serves as genetic material in some viruses. RNA contains the pyrimidine **uracil** in place of thymine found in DNA.

Types of RNA

Messenger (*m*RNA)	**Ribosomal (*r*RNA)**	**Transfer (*t*RNA)**
It constitutes 5% of total RNA. It carries coded information for translation into polypeptide. It contains 5′methylated cap, initiation codon (AUG) and termination codon (UAA, UAG, UGA).	It constitutes 80% of total RNA. It provides structural framework for ribosomes. Depending on sedimentation coefficient, eukaryotic *r*RNA is of 4 types - 28S, 18S, 5.8S and 5S while prokaryotic *r*RNA is of three types-23S, 16S and 5S.	It constitutes 15% of total RNA and also called as soluble RNA. It transfers amino acids to ribosomes for polypeptide synthesis. It is smallest RNA having sedimentation coefficient of 4S . It contains AA binding site, DHU loop, T Ψ C loop, anticodon loop and extra arm.

INTEXT PRACTICE QUESTIONS

3. **What type of bonds are involved in secondary structure of protein?**
4. **How does the monomeric deoxynucleotides are held together in DNA?**

ENZYMES

- Enzymes are usually the most remarkable and highly specialised proteins having an extraordinary catalytic power and high degree of specificity for their substrates.
- Since enzymes are capable of catalysing reactions of biological origin and are synthesised by living cells only they are called **biocatalysts**.
- The term 'enzyme' was first coined by **Kuhne** (1877) for catalytically active substances.
- However the enzymes were first discovered and isolated by **Buchner** (1897). For this he was awarded Nobel Prize in 1903.

Chemical Nature of Enzymes

- Some enzymes may also contain non-proteinaceous molecules and metal ions that participate directly in substrate binding or catalysis.
- Based on presence or absence of non-protein group, enzymes are of two types:

Simple enzymes

- Made up of protein only. Active site comprises of specific grouping of its own amino acids. *E.g.,* pepsin, trypsin etc.

Conjugate enzymes

- These are made up of two parts: Apoenzyme (Protein part) and Co-factor (Non-Protein part)
- The complete enzyme is called **holoenzyme**.
- The active site is formed jointly by apoenzyme and co-factor.
- **Apoenzyme** is protein part of holoenzyme. It is large in size and is specific for an enzyme.
- **Co-factor** is small, heat stable and dialysable part of conjugate enzyme which may be organic or inorganic in nature.
- Organic co-factors are of two types: **Co-enzymes** and **prosthetic groups**.
- **Co-enzymes** are easily separable non-protein organic co-factors that act as transient carriers of specific functional groups. Co-enzymes require two apoenzymes one for picking up the group and second for transferring the group *e.g.*, NAD^+, $NADP^+$, CoA.
- Most of the co-enzymes are made up of water soluble vitamins B and C, *e.g.,* thiamine, riboflavin, nicotinamide, pyridoxine, etc.
- **Prosthetic groups** are non protein organic co-factors firmly attached to apoenzymes and take part in group transfer reactions, *e.g.,* heme, biotin, pyridoxal phosphate.
- **Inorganic co-factors** include ions of a variety of minerals, *e.g.,* calcium, iron, copper, zinc, nickel, molybdenum etc.

They usually function as activators by forming one or more coordination bonds with both the substrate and active site of enzyme.

- Active site of enzyme is the small portion of enzyme that takes part in catalysing biochemical reaction by attracting and holding particular substrate molecule by its specific charge, size or shape.
- Active site consists of a few amino acids and their side groups which are brought together in a particular fashion due to secondary and tertiary folding of a protein molecule and its association with the cofactor, if any. An enzyme may have more than one active site.
- The molecule or biochemical acted upon by an enzyme is known as **substrate** and if more than one biochemical are involved in a reaction, they are called **reactants**. The chemicals formed after the completion of reaction are called **products**.

Classification of Enzymes

- According to modern system of enzyme classification, introduced by **International Union of Biochemistry and Molecular Biology (IUBMB)** in 1961, enzymes are classified into six classes, based on the type of reaction catalysed.

Classification of Enzymes

Oxidoreductases

These enzymes catalyse the oxidation-reduction reactions by transfer of electrons. These enzymes are of three types - **Oxidases,** *e.g.*, cytochrome oxidase, **dehydrogenases,** *e.g.*, succinate dehydrogenase and **reductases,** *e.g.*, nitrate reductase.

$$NADH + H^+ + \frac{1}{2}O_2 \xrightarrow[\text{oxidase}]{\text{Cytochrome}} NAD^+ + H_2O$$

Transferases

These enzymes catalyse the transfer of specific group from one substrate to another. The group transfer does not occur in free state.

$$\underset{\text{(amino acid)}}{\text{Glutamic acid}} + \underset{\text{(organic acid)}}{\text{Oxaloacetic acid}} \xrightarrow{\text{Transferase}} \underset{\text{(organic acid)}}{\alpha\text{-ketoglutaric acid}} + \underset{\text{(amino acid)}}{\text{Aspartic acid}}$$

Hydrolases

These enzymes catalyse splitting of larger molecules into smaller ones by addition of water (hydrolysis of bonds), *i.e.*, with the help of hydrogen and hydroxyl groups. Usually bonds formed by dehydration condensation, *i.e.*, ester, ether, glycosidic are catalysed by these enzymes, *e.g.*, amylase, sucrase, lactase.

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Maltose + Isomaltose} + \alpha\text{-Dextrins}$$

Lyases

These enzymes catalyse the breakdown of specific covalent bonds and removal of groups without hydrolysis producing double bonds or removal of double bonds by adding groups.

$$\text{Fructose 1,6-diphosphate} \xrightleftharpoons{\text{Aldolase}} \text{3-phosphoglyceraldehyde + Dihydroxyacetone phosphate}$$

Isomerases

These enzymes catalyse the change of a substrate into a related isomeric form by rearrangement of molecules.

These enzymes too are of three types: **Isomerases** (change aldose to ketose group or *vice-versa*), **Epimerases** (change in position of one constituent or carbon group), **Mutases** (shift the position of side group like Glucose-6-phosphate → Glucose-1-phosphate).

$$\text{Glucose 6-phosphate} \xrightleftharpoons[\text{isomerase}]{\text{Phosphohexose}} \text{Fructose 6-phosphate}$$

Ligases

These enzymes catalyse the joining of two substrate molecules by utilising the energy from hydrolysis of ATP.

$$\text{Pyruvate} + CO_2 + \text{ATP} + H_2O \xrightarrow[\text{carboxylase}]{\text{Pyruvate}} \text{Oxaloacetate + ADP + Pi}$$

Characteristics of Enzymes

- **Proteinaceous nature -** Enzymes are usually globular proteins except two RNA enzymes.
- **Efficiency -** The efficiency of enzyme depends upon the number of active sites present over an enzyme. The number of substrate molecules changed per minute by an enzyme is called **turn over number**. The higher the turn over number, the more efficient an enzyme is.
- **Enzyme specificity -** Enzymes are highly specific in their action. Different enzymes act on same substrate but give rise to different products. Similarly, an enzyme may act on different substrates to produce different end products.
- **Chain of reactions -** Enzymatic reactions are not isolated, they occur in quick succession or a team of enzymes (complex) work together to perform multistep reactions.
- **Colloidal nature -** Enzymes are hydrophillic and form hydrosol in free state.
- **Reversibility -** Almost all enzymatic reactions are reversible. However, reversibility is dependent upon energy requirements, availability of reactants, concentration of end products and pH.

What Z it?

SOLUTION AUGUST 2019

Kiwa hirsuta

(Yeti Crab)

Winner : *Hussain Atif Ali (Odisha), Sanjivani Dutta, Shreya A. Hegde (Karnataka), Tamal Bhaumik (Kolkata), Nitun Sarkar (Kolkata)*

- **Thermolabile -** Enzymes are heat sensitive or thermolabile and operate between 25-35°C (optimum temperature range). They become inactive at freezing temperatures and denature at 50-55°C.
- **Enzyme-substrate complex -** The active sites of enzymes have crevices or conformations that fit in the substrates in a complementary fashion forming a complex known as enzyme substrate complex. The latter are changed into products. As soon as the products are released, the active sites become free to perform another catalytic act.

MECHANISM OF ENZYME ACTION

- The mechanism of enzyme action can be studied under two steps :

Lowering of Activation Energy

- Most of the chemical reactions have an energy barrier separating the reactants and products.
- Therefore an external supply of energy is needed for the start of chemical reaction. This energy is called **activation energy** which is quite high for the non-catalysed reactions and is lowered by the enzyme. The activation energy increases the kinetic energy of the system and brings about forceful collisions between the reactants. Enzyme lowers activation energy of a reaction by : taking the reactants out of solution state (desolvation), establishing weak bonds between reactants and enzymes, bringing reactant molecules, close to one another in the region of active sites and developing strain in reactants bonds by electrophillic and nucleophillic attack.

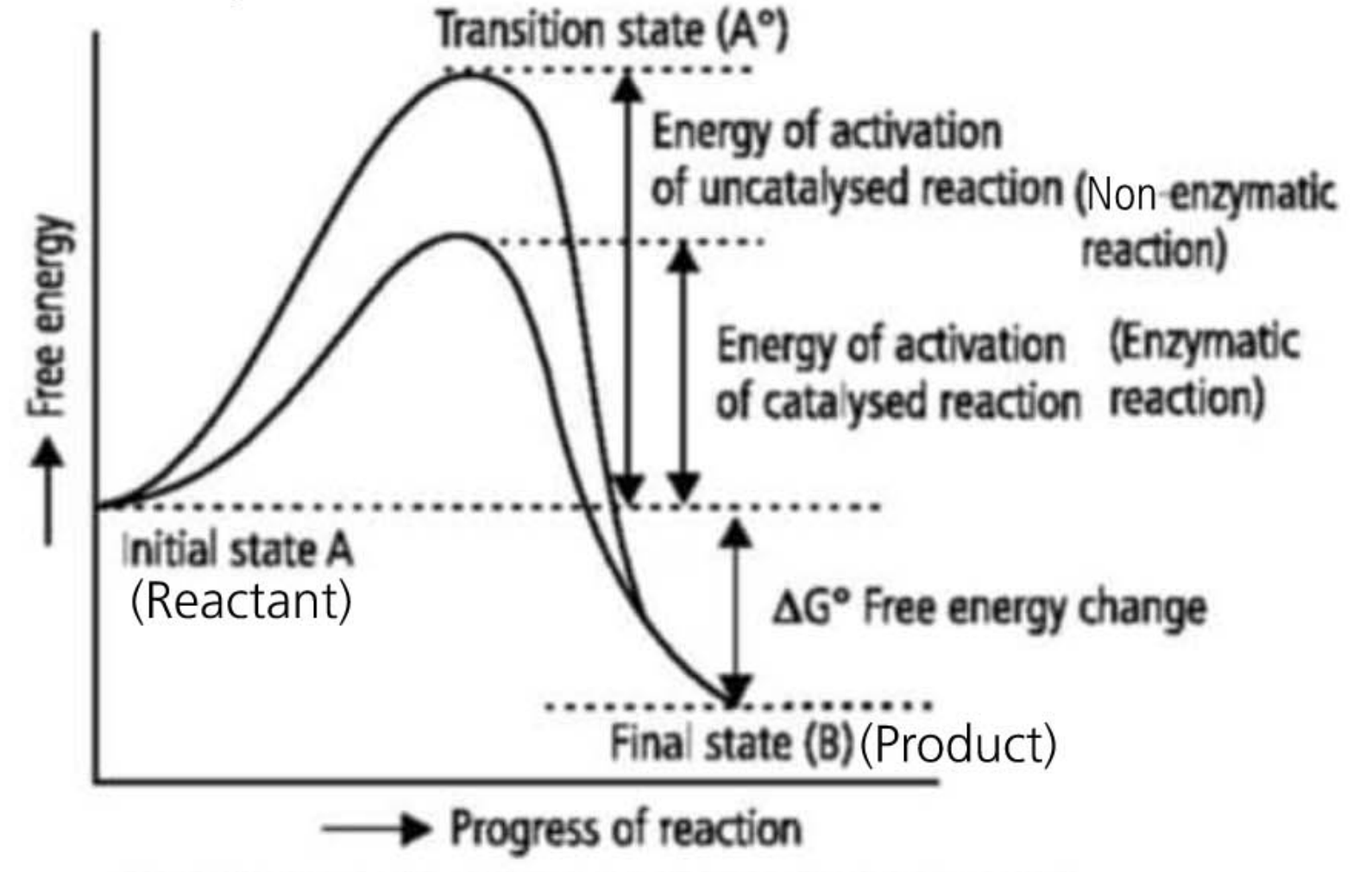


Fig.: Diagram showing a change in the free energy content of the enzyme catalysed reaction.

Formation of Enzyme-Substrate Complex

- All enzymes have a specific three-dimensional structure and a part of it is known as **active site** into which substrate fits to proceed chemical reactions. The point where substrate is bound on the active site is known as the **substrate binding site.** The first step in an enzymatic reaction is that the enzyme forms a temporary association with its substrate called **enzyme substrate complex** (E – S complex). Following two models have been proposed to explain the formation of E – S complex.

(i) Lock and key hypothesis

- **Emil Fischer** (1894) proposed that as a particular lock can be opened by only a particular key, similarly a substrate of specific shape fits into a specific active site on the enzyme surface. This suggests that both enzyme and substrate molecules have specific geometrical shapes and form an enzyme substrate (ES) complex. This also explains the **specificity** of enzyme action.

(ii) Induced fit hypothesis

- **Koshland** (1959) proposed that the active sites of an enzyme are not rigid. When the substrate binds to an enzyme, it may induce conformational change in enzyme molecule in such a way that it is fit for the substrate-enzyme interaction.

Factors Affecting Enzyme Activity

Temperature

- An enzyme is active within a narrow range of temperature. The temperature at which an enzyme shows its highest activity is called **optimum temperature**. The optimum temperature for most of the enzymes is between 25°C - 35°C. Temperature above and below this range affects the enzyme activity.

Enzyme concentration

- The rate of enzymatic reaction increases with the increase in enzyme concentration upto a point called **saturation point**. Above this limit, there is little effect on enzyme activity.

pH

- Enzymes work at their own optimum pH. A rise or fall in pH reduces enzyme activity by changing the degree of ionisation of its side chains.

Substrate concentration

- Initially the rate of enzymatic reaction increases with the increase in substrate concentration. In beginning, the velocity of reaction is high but later it does not increase progressively with the increase in substrate concentration. It happens because enzyme molecules get fully saturated and no active site is left free to bind additional substrate.

Activators and poisons

- Some chemical substances or molecules increase activity of enzymes such as co-factors, *e.g.*, K^+, Mn^{2+} etc. On the other hand, salts of heavy metals and compounds such as cyanides, azides, iodoacetate destroy tertiary structure of enzymes thus affecting enzyme activity.

Michaelis-Menten Equation

- Michaelis-Menten equation mathematically illustrates the relationship between initial reaction velocity and substrate concentration.
- Here, the Km (Michaelis Menten constant) is a mathematical derivative which indicates the substrate concentration at which the reaction catalysed by an enzyme attains half its maximum velocity.

- Km indicates affinity of the enzyme for its substrate. A high Km indicates low affinity while a low Km indicates strong affinity.
- The Km value generally lies between 10^{-1} to 10^{-6} M.
- K_m, the Michaelis – Menten constant (or Brig's and Haldane's constant), is given by the formula $K_m = \frac{k_2 + k_3}{k_1}$; here k_1, k_2 and k_3 represent the velocity constants for the respective reactions as shown below.

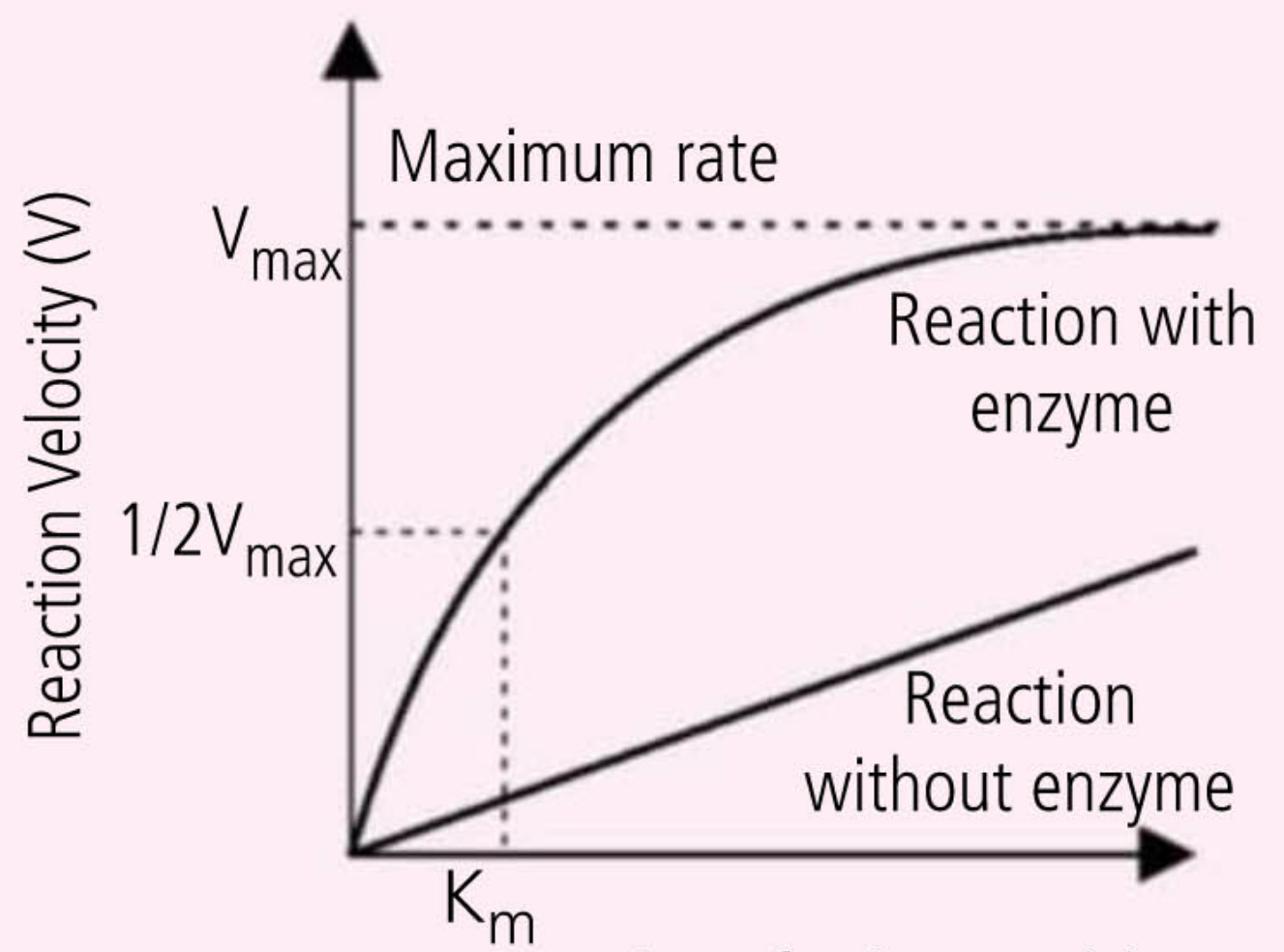


Fig.: Effect of substrate concentration on reaction velocity with or without enzyme.

The Michaelis-Menten equation obtained after suitable algebraic manipulation is $V = \frac{V_{max}[S]}{K_m + [S]}$ where V = Measured velocity, V_{max} = Maximum velocity, S = Substrate concentration, K_m = Michaelis-Menten constant.

INHIBITION OF ENZYME ACTION

- The reduction or cessation of enzyme activity due to presence of certain adverse conditions or chemicals is called enzyme inhibition.

On the Basis of Nature of Inhibition

Reversible inhibition

- Temporary inhibition that can be overcome by withdrawal of inhibitor. It occurs due to blocking of active site or binding to linkages required for maintenance of active site. It is characterised by rapid dissociation of enzyme inhibitor complex. Dilution and dialysis reduces or eliminates the effect of reversible inhibition.

Irreversible inhibition

- Permanent inhibition of enzyme due to the change or destruction in conformation of enzyme. It occurs due to covalent binding of heavy metals or other inhibitors with the enzymes, resulting in their inactivation.

On the Basis of Causes of Inhibition

Competitive Inhibition

- The inhibitor closely resembles the real substrate (S), and is regarded as a **substrate analogue**. The inhibitor competes with substrate and binds at the active site of the enzyme, but does not undergo any catalysis. As long as the competitive inhibitor holds the active site, the enzyme is not available for the substrate to bind.
- Competitive inhibition is usually reversible. The classical example of competitive inhibition is enzyme **succinate dehydrogenase** with succinic acid as its substrate. Malonate, oxaloacetate are its inhibitor which resemble succinic acid.

Non-Competitive Inhibition

- The inhibitor binds at a site other than the active site on the enzyme surface. This binding impairs the enzyme function. The inhibitor has no structural resemblance with the substrate. It does not interfere with the enzyme-substrate binding but the catalysis is prevented, possibly due to a distortion in the enzyme conformation.
- Non-competitive inhibition is usually irreversible.
- The inhibitor generally binds with the enzyme as well as the enzyme substrate complex.
- Common example of non-competitive inhibition is inhibition of respiratory enzyme cytochrome oxidase by cyanide that combines with its metallic ions. It has no structural similarity with the substrate of the enzyme cytochrome *c*.

Allosteric Inhibition (Feedback Inhibition)

- It is a type of reversible inhibition found in allosteric enzymes. The inhibitor is non-competitive and is usually a low molecular weight intermediate or product of a metabolic pathway having a chain of reactions involving a number of enzymes. It is, therefore, also called end product or **feed back inhibition**.
- The inhibitor is also called **modulator**. Modulator is a substance that attaches with an allosteric enzyme at a site other than catalytic one but influences the latter, either inhibiting or activating the same. An example of feed back or allosteric inhibition is stoppage of activity of enzyme **hexokinase** (glucokinase) by **glucose-6-phosphate**, the product of reaction catalysed by it.

METABOLITES

- Metabolites are biomolecules or organic compounds that are constantly utilised (catabolism) or formed (anabolism) in various metabolic reactions occurring inside the cells.
- Plants and microbes produce several organic compounds that may be required for their basic metabolic process while at the same time they also synthesise compounds that do not participate in metabolic pathways.
- On this basis, metabolites are of two types :
  - **Primary metabolites :** Some of the organic compounds like carbohydrates, fats, proteins, nucleic acids, etc., are required for basic metabolic processes and are directly involved in normal growth, development and reproduction. These organic compounds are called primary metabolites.
  - **Secondary metabolites :** Many plants, fungi and microbes of certain genera synthesise a number of organic compounds which are not involved in primary metabolism (photosynthesis, respiration, protein and lipid metabolism) and seem to have no direct function in growth and development of plants. These compounds are called secondary metabolites *e.g.*, gum, resin, rubber etc. Secondary metabolites can be **isoprenoids** or **terpens** (*e.g.*, rubber, steroids), **'N' containing compounds** (*e.g.*, alkaloids, glycosides) and **Phenolic compounds** (*e.g.* tannins, flavonoids).

INTEXT PRACTICE QUESTIONS

5. How does enzyme lowers down activation energy of a reaction?

6. Non-competitive inhibition is not reversible. State the reason.

Cell Cycle and Cell Division

CELL CYCLE

- The sequence of events by which a cell duplicates its genome, synthesises cell content and eventually divides into two daughter cells is termed as **cell cycle**.
- A typical eukaryotic somatic cell has two main stages: a long undividing **interphase (I-phase)** and a shorter nucleus dividing **mitotic phase (M-phase)** followed by **cytokinesis**. Interphase is metabolically active stage and is divided into **first gap phase(G_1-phase), synthesis phase (S-phase)** and **second gap phase (G_2-phase).**

Gap 1 (G_1) Phase

- It is the first or **primary growth phase** (post mitotic gap phase) of the cell. This phase is between end of M-phase of previous cell cycle and initiation of S-phase.
- This is the longest phase of interphase and its duration is variable. It is longer for rarely dividing cells and shorter for frequently dividing cells.
- Cell is metabolically active and grows in size, RNA and proteins are synthesised, large number of nucleotides, amino acids for histone synthesis and energy rich compounds are formed. Cell organelles also increase in number.
- In this phase, cell basically prepares for DNA synthesis.
- From this phase, cell may opt either of the paths - enter S-phase, enter G_0 phase or get arrested in G_1 phase.

Synthesis (S) Phase

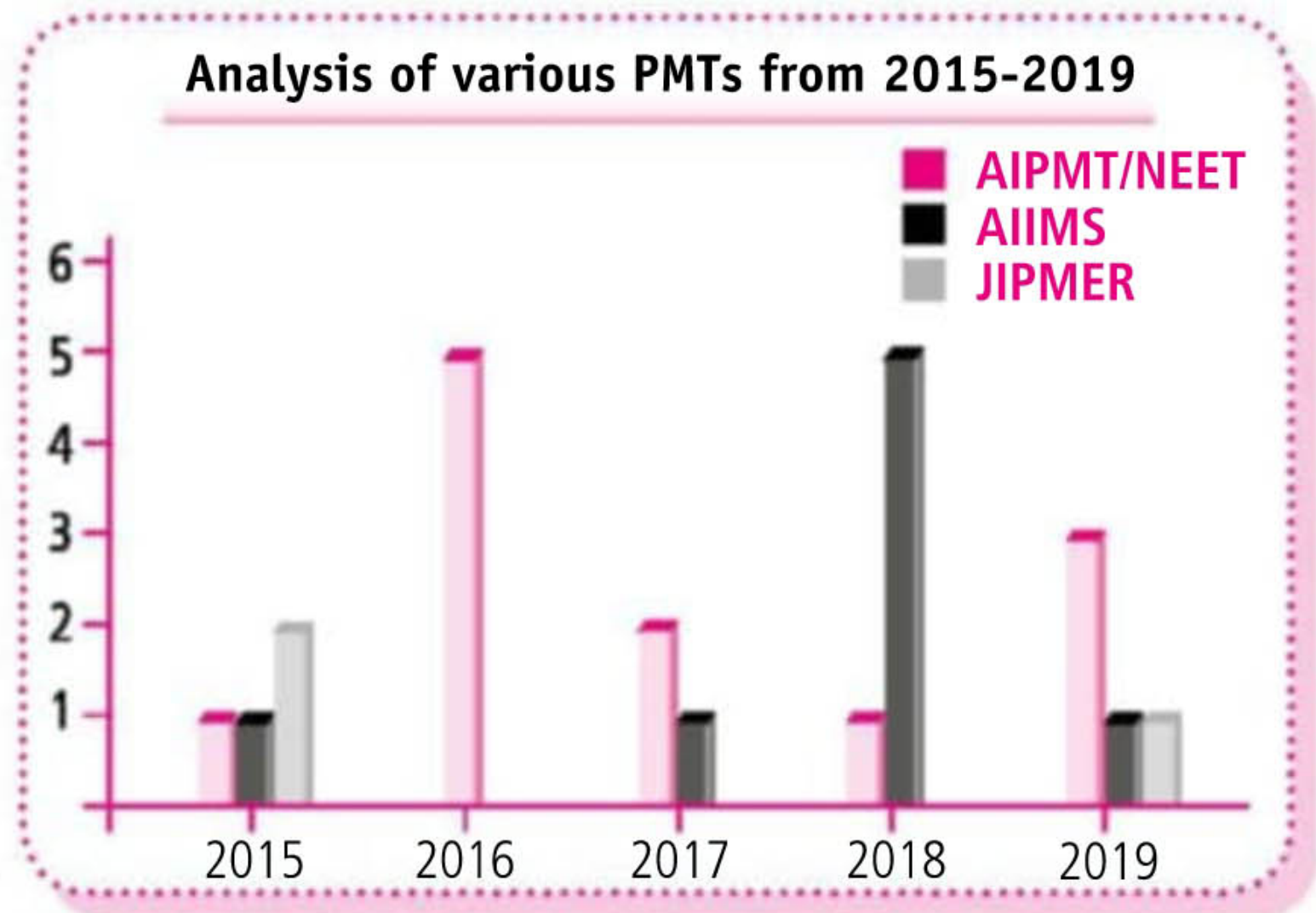
- It is the phase of DNA synthesis or chromosome replication.
- Each chromosome replicates to produce two sister chromatids, which remain attached at the centromere.
- DNA content doubles and hence duplicate sets of genes are formed.
- After chromosomes replicate, they remain fully extended and uncoiled. This makes them invisible under the light microscope, hence called **invisible phase**.

Gap 2 (G_2) Phase

- It is the **second growth phase** (pre-mitotic gap phase).
- Cell prepares for division or genomic separation synthesised in S phase.
- Mitochondria and other organelles replicate, chromosomes condense (coiling even more tightly), RNAs and proteins are formed and microtubules begin to assemble at a spindle.
- In general, cells begin to assemble the machinery they will later use to move the chromosomes to opposite poles of the cell.
- In animal cells, centrosome also begins to divide to form two centrosomes or pair of centriole. There is extensive synthesis of tubulin protein to form microtubules.

G_0 Phase (Quiescent stage)

- Some cells pause in G_1 phase or withdraw from the cell cycle before DNA replication and enters a resting state called G_0 phase.
- Cell remains metabolically active but do not grow or differentiate.
- Cell may resume growth and enters G_1 stage whenever required.
- At any given time, most of the cells in an animal's body are in G_0 phase midway and enter in **differentiation phase.** Then they grow in size, adopt specific shape and function.



Regulation of Cell Cycle

- Two key classes of regulatory molecules, **cyclins** and **cyclin-dependent protein kinases (CDKs),** determine a cell's progress through the cell cycle.
- Cyclins have no catalytic activity and CDKs are inactive in the absence of partner cyclin.
- CDKs are constitutively expressed in cells whereas cyclins are synthesised at specific stages of the cell cycle, in response to various molecular signals.
- When activated by a bound cyclin, CDKs perform a common biochemical reaction called **phosphorylation** that activates or inactivates target proteins to orchestrate the co-ordinated entry into the next phase of the cell cycle.
- Different cyclin-CDK combinations determine the downstream targeted proteins.

Cell cycle check points

- These are the control mechanism that ensure the fidelity of cell division. There are two regulatory mechanisms, which take decision about cell division.
- **First check point** is called G_1 cyclin (C_{G1} or G_1/S) that lies in between G_1 and S. In G_1, CDK become active by G_1 cyclin and ATP at its activation site. It causes transition of G_1 to S phase. G_1 cyclin is destroyed at the end of S phase and CDK becomes inactive.
- **Second check point** lies between G_2 and M-phase. In G_2 phase, inactive CDK binds to mitotic cyclin (C_M or G_2/M). It gets phosphorylated at its both activation and inhibitory sites but still remains inactive. On removal of PO4 from the inhibitory site, it becomes active and causes transition from G2 to M phase. At the end of M phase, cyclin C_M is degraded and PO_4 at activation site is removed and the cell enters G_1 again.

CELL DIVISION

- The process of formation of new or daughter cells from pre-existing or parent cells is called cell division. Three types of cell division are : amitosis, mitosis and meiosis.
- Cell division is important for maintenance of cell size, cell repair, continuity of living beings, reproduction and regeneration, etc.

Amitosis

- Amitosis is a direct division characterised by the splitting of nucleus followed by that of cytoplasm.
- Amitosis is a simple method of cell division described by **Flemming** (1882). In this method, the nucleus elongates and constricts in the middle to form two daughter nuclei. This is followed by a centripetal constriction of the cytoplasm to form two daughter cells, *e.g.*, in meganucleus of *Paramecium*.

Mitosis

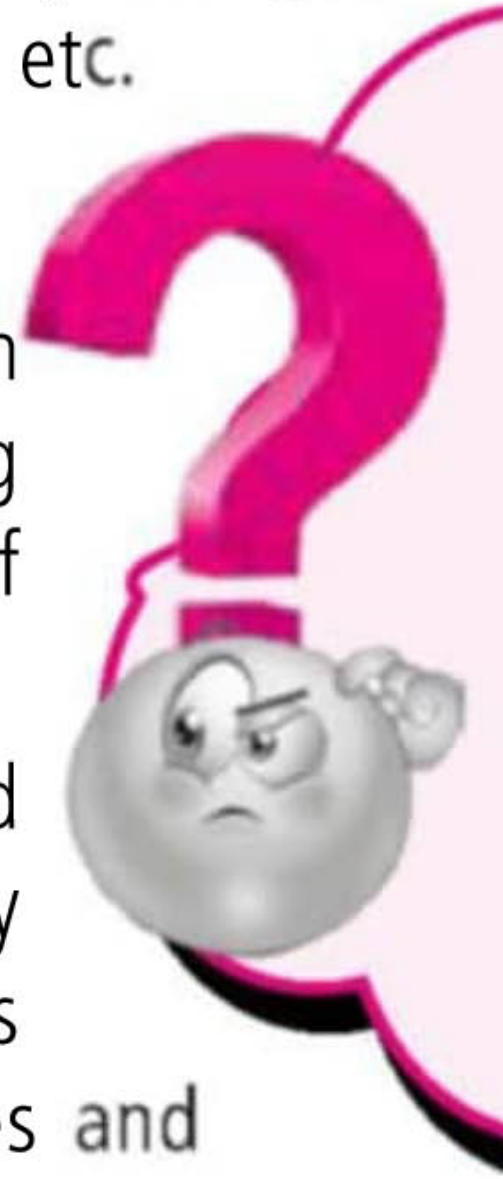
- Mitosis or mitotic cell division is meant for multiplication of cells. Development of complete organism from zygote occurs by means of mitotic cell division. So, mitosis is necessary for maintenance, growth, repair and continuity of life.
- Mitosis generally takes place in vegetative or somatic cells.
- In this process, one parent cell divides into two daughter cells, but the chromosome number remains the same as in parent cell, *i.e.*, **daughter cells exactly resemble with parent cell both quantitatively as well as qualitatively.** So mitosis leads to increase in number of cells without any change in genetic make-up.
- Mitosis can be easily observed in meristematic cells of plant. Root tips (*e.g.*, onion root tips) are considered to be the best material for the study of mitosis.
- **W. Flemming** (1882) gave the term mitosis (Gr.: *Mitos*-thread + *osis*-state). However, mitosis was first observed in plants by **E. Strasburger** (1870) and in animals by **Boveri** and **Flemming** (1879).
- Mitosis consists of two steps - **karyokinesis** and **cytokinesis**.

Karyokinesis

- Karyokinesis is the division of nucleus that consists of four stages – **Prophase, metaphse, anaphase** and **telophase**. Cytokinesis is the division of protoplast.

Prophase

- Prophase is the first stage of mitosis that follows the G_2 phase of interphase.
- In the S and G_2 phases, the new DNA molecules formed are not distinct but intertwined.
- Prophase is marked by the initiation of condensation of chromatin material.
- Each chromosome consists of two coiled sister chromatids joined by a centromere. Their ends are not visible in early prophase. Therefore, the chromosomes appear like a ball of wool. It is also called **spireme stage.**
- Viscosity of cytoplasm increases. Chromatin fibres become shorter and thicker due to the coiling and folding and get condensed into distinct thread-like chromosomes in late prophase.



WHO AM I ...

"I am a phase of cell cycle marked with intense growth and constitute 95% of duration of cell cycle."

...search me ☺

- The centriole, which had undergone duplication during S-phase of interphase, now begins to move towards opposite poles of the cell.
- Fine radiating microtubules appear around each pair of centrioles to form **astral rays.**
- Cells at the end of prophase, when viewed under the microscope, do not show Golgi complexes, endoplasmic reticulum (ER), nucleolus and the nuclear envelope.

Metaphase

- The complete disintegration of the nuclear envelope marks the start of the second phase of mitosis, *i.e.*, metaphase, hence the chromosomes are spread through the cytoplasm of the cell.
- By this stage, condensation of chromosomes is completed and they can be observed clearly under the microscope. The number and morphology of chromosomes can be easily studied and counted.
- Small disc-shaped structures at the surface of the centromeres called **kinetochores** serve as the sites of attachment of spindle fibres formed by the centrioles.
- Spindle fibres which radiate from one pole but do not reach the other end of pole, are **discontinuous fibres** that connect the pole to the chromosomes at the kinetochores. These are called **chromosomal fibres** and those which extend without interruption from one pole to other are called **continuous fibres.**
- In animal cells and lower plants, centrioles are present and asters radiate from the centriole, which form spindle fibres. This type of mitosis is called **astral** or **amphiastral mitosis.**
- In higher plants, there are no centrioles and hence no asters are formed, so this type of mitosis is called **anastral mitosis.**
- Due to attachment of spindle fibres at the centromeres, the chromosomes get arranged in the centre or at **equator** and form **equatorial plate** or **metaphase plate** of the cell.
- Hence, metaphase is characterised by **all the chromosomes lying at the equator** with one chromatid of each chromosome connected by its kinetochore to spindle fibres from one pole and its sister chromatid connected by its kinetochore to spindle fibres from the opposite pole.

Anaphase

- This is the **shortest stage** of mitosis.
- Chromosomes divide at the point of centromere of kinetochore and thus two sister chromatids, now referred to as chromosomes of the future daughter nuclei, are formed.
- Interzonal fibres appear between the daughter centromeres (*i.e.*, formed after division of centromere).
- These sister chromatids of future chromosomes or daughter chromosomes now move towards the opposite poles of spindle and this movement occurs due to repulsion between centromeres, contraction of spindle fibres and relaxation of interzonal fibres.
- Different shapes of chromosomes may be observed at anaphase (V or J or L or I-shaped), depending upon position of kinetochore or centromere.

Telophase

- Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements.
- Disintegration of spindle fibres occur and nuclear envelope assembles around the chromosome clusters.
- Cytokinesis begins as the plane of constriction forms. Nucleolus, Golgi complex and ER reform. It is **reverse** of prophase.

Cytokinesis

- Mitosis accomplishes not only the segregation of duplicated chromosomes into daughter nuclei, but the cell itself is divided into two daughter cells by the process of cytokinesis at the end of which cell division is completed.
- Cytokinesis is the **last step** of M-phase. It starts towards the middle of anaphase and is completed with the telophase.

Significance of Mitosis

- **Growth and development:** A single celled zygote grows into full grown baby by repeated mitosis. Plants are able to grow throughout their life due to mitotic divisions in their apical and lateral meristems.
- **Genetic stability:** All the daughter cells of a multicellular organism have the same number and type of chromosomes as parent cells due to equitable distribution of all the chromosomes.
- **Repairing:** The mechanism for replacing old or worn out cells is called repairing.
- **Healing and regeneration:** For healing of a wound, new cells are produced by mitosis. Some organisms are able to regenerate missing parts of body or also whole organism through mitosis.

INTEXT PRACTICE QUESTIONS

7. **In which phase of cell division, we can see the V, L, J and I shapes of chromosomes?**
8. **Name the stage of cell cycle at which centromere splits and chromatids separate.**

Meiosis

- Meiosis is a double division which occurs in a diploid cell (or nucleus) and gives rise to four haploid cells (or nuclei), each having half the number of chromosomes as compared to the parent cell. The term meiosis was coined by **Farmer** and **Moore**.
- Meiosis involves two successive nuclear divisions meiosis-I and meiosis-II, but no DNA replication prior to second division. Meiosis occurs in gametes. Cells in meiosis are called **meiocytes,** *e.g.*, spermatocytes and oocytes respectively.

Meiosis-I

- The **heterotypic** or **reduction division is the first division of meiosis**. It starts after the interphase of the cell cycle. During this division the number of chromosomes is reduced to half. Like mitosis, it is studied under four stages — **prophase-I**, **metaphase-I**, **anaphase-I** and **telophase-I**.

Prophase-I

- It is more complicated and the longest phase of meiotic division. It is longer than the prophase of mitosis. It is divided into five sub-phases — **leptotene, zygotene, pachytene, diplotene** and **diakinesis**.
- In prophase-I, the DNA coils tighter and individual chromosomes first become visible under the light microscope as a matrix of fine threads. Sex chromosomes (if present) are often seen as **heterochromatic (heteropycnotic) bodies.**
- **Leptotene** or **leptonema** is a period in which the nucleus has increased in size and the chromosomes have become more apparent. The leptotene chromosomes show bead-like thickenings called **chromomeres,** which appear at irregular intervals along their length. Leptonemic chromosomes have a definite polarisation and form loops whose ends are attached to the nuclear envelope at points near the centriole. This peculiar arrangement is often called the "**bouquet**" stage. The centriole pair begin to move to the opposite side. Both the centriole pairs or centrosomes develop **astral rays** from the pericentriolar satellites.
- During **zygotene**, the two homologous chromosomes get attached to each other laterally due to the formation of nucleoprotein **synaptonemal complex** between them. The process of attachment of the homologous chromosomes is known as **synapsis**.
- **Pachytene** is the longest phase of prophase-I. This stage is characterised by the appearance of recombination nodules, the sites at which crossing over occurs between non-sister chromatids of the homologous chromosomes (bivalent/dyad). Each bivalent or chromosome pair is made up of actually four chromatids *i.e.*, two of each chromosome. The two chromatids belong to the same chromosome are called sister chromatids and chromatids belong to different chromosomes of homologous pair are termed as non-sister chromatids.
- In **diplotene** or **diplonema,** the nucleoprotein fusion complex of the synapsed chromosomes dissolves partially. Therefore, the homologous chromosomes separate except in the region of crossing over. The chromatids also become distinguishable (**tetrad stage**). The points of attachment between the homologous chromosomes after the partial dissolution of nucleoprotein complex are called **chaismata**.
- In **diakinesis**, chiasmata shift towards the ends of the chromosomes. The phenomenon is called **terminalisation**. The bivalent of satellite chromosomes remains united with the nucleolus for some time. The nucleolus ultimately degenerates. Simultaneously, nuclear envelope disintegrates. The probability that crossing-over will occur between two loci increases with increasing distance between the two loci (the location of a gene on a chromosome is called a locus) on the chromosome.

Metaphase-I

- The bivalents arrange themselves on the equator of the bipolar spindle. The limbs of the chromosomes are usually short and lie horizontally on the equator. The centromeres slightly project towards the periphery. Since, there are two centromeres in each bivalent, the centromeres of all the bivalents produce a double metaphasic plate. The distribution of bivalents is at random so that the individual paternal and maternal chromosomes can face either of two poles of the spindle. Each joined pair of homologues then lines up on the **metaphase plate.**

Anaphase-I

- In anaphase -I, the microtubules of the spindle fibres begin to shorten. As they shorten, they break the chiasmata and pull the centromeres towards the poles, dragging the chromosomes along with them. Because the microtubules are attached to kinetochores on only one side of each centromere, the individual centromeres are not pulled apart to form two daughter centromeres, as they are in mitosis. Instead, the entire centromeres move to one pole, taking both sister chromatids with it. When the spindle fibres have fully contracted, each pole has a complete haploid set of chromosomes consisting of one member of each homologous pair.
- Because of the random orientation of homologous chromosomes on the metaphase plate, a pole may receive either the maternal or the paternal homologue from each chromosome pair.

Telophase-I

- The polar groups of chromosomes arrange themselves into haploid nuclei. The chromosomes elongate. A nucleolus is formed by the satellite chromosome. It is followed by the appearance of nucleoplasm and nuclear envelope. The elongated chromosomes usually remain straight and do not enter the interphase. Cytokinesis may or may not follow division I of meiosis.

Interkinesis

- It is **metabolic stage** between telophase of meiosis-I and prophase of meiosis-II.
- **Protein** and **RNA synthesis** may occur. Centrosomes or centriole pairs undergo replication in animal cells. There is **no DNA synthesis**. It is short lived and important to bring **true haploidy** in daughter cells.

Meiosis–II

- It is called **homotypic** or **equational division**, because it maintains the number of chromosomes produced at the end of reduction division.
- Meiosis–II is divisible into **prophase–II**, **metaphase–II**, **anaphase II** and **telophase–II**.

Cytokinesis

- It can be divided into two types : successive and simultaneous types.
- **Successive type:** Cytokinesis occurs after every nuclear division that results in formation of four cells arranged in a linear or isobilateral tetrad.
- **Simultaneous type:** Cytokinesis takes place only at the end of both divisions that results in formation of a tetrahedron.

All those substances or chemicals which prevents the cells from entering into normal mitotic divisions are called mitotic poisons, *e.g.*, mustard gas, chalones, colchicine, etc.

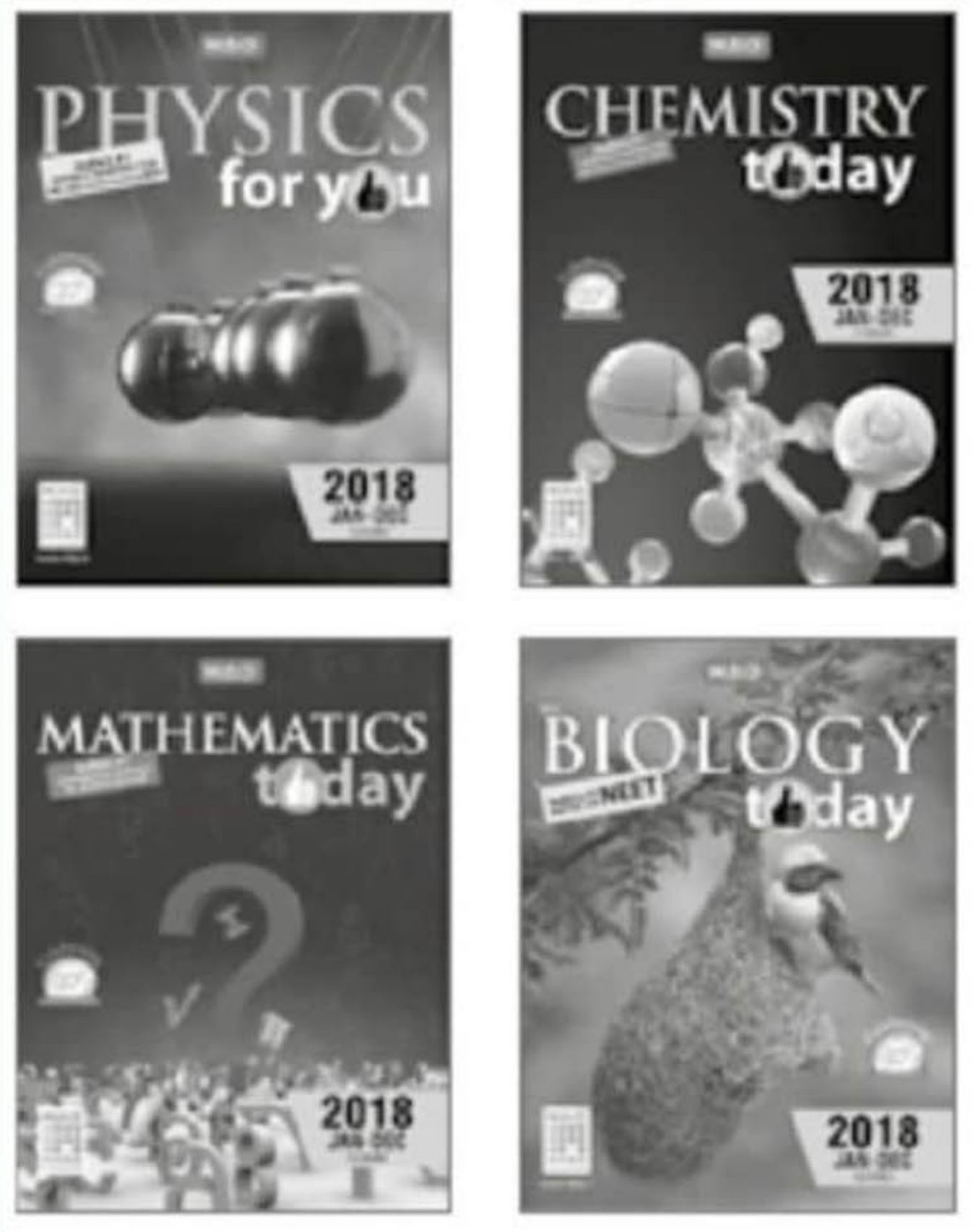
Significance of Meiosis

- Meiosis is essential for formation of gametes and maintenance of chromosome number in sexually reproducing organisms. Gametes produced by meiosis have half the number of chromosomes. It is essential to maintain **species specific number of chromosomes**, since the chromosome number becomes double after fertilisation.
- In meiosis, paternal and maternal chromosomes **assort independently** that causes reshuffling of chromosomes and the traits controlled by them.
- **Crossing over** results in new combination of traits and produce variations. **Variations** serve as raw material for **evolution** of new species.
- Details of meiosis are essentially similar in the majority of organisms showing their **basic similarity** and **relationship**.

INTEXT PRACTICE QUESTIONS

9. Who coined the term 'meiosis'?

10. In which stage of cell division tetrad formation occur?



AVAILABLE BOUND VOLUMES

of your favourite magazines

Physics For You 2018 (January - December)	₹ 380	12 issues
Chemistry Today 2018 (January - December)	₹ 380	12 issues
Mathematics Today 2018 (January - December)	₹ 380	12 issues
Biology Today 2018 (January - December)	₹ 380	12 issues
Physics For You 2017 (January - December)	₹ 325	12 issues
Chemistry Today 2017 (January - December)	₹ 325	12 issues
Mathematics Today 2017 (January - December)	₹ 325	12 issues
Biology Today 2017 (January - December)	₹ 325	12 issues
Physics For You 2016 (January - June)	₹ 175	6 issues
Mathematics Today 2016 (January - December)	₹ 325	12 issues
Biology Today 2016 (January - June)	₹ 175	6 issues
Chemistry Today 2016 (January - June)	₹ 175	6 issues

How to order : Send money by demand draft/money order. Demand Draft should be drawn in favour of **MTG Learning Media (P) Ltd.** Mention the volume you require along with you name and address. OR buy online from www. mtg.in

Add ₹ 90 as postal charges

Older issues can be accessed on **digital.mtg.in** in digital form.

Mail your order to :

Circulation Manager, MTG Learning Media (P) Ltd.
Plot No. 99, Sector 44 Institutional Area, Gurugram, (HR)
Tel.: (0124) 6601200
E-mail : info@mtg.in Web : www.mtg.in

buy online at www.mtg.in

MONTHLY TEST DRIVE

XI

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160

Series 4: • Structural Organisation in Animals
• Cell : The Unit of Life

Time Taken : 40 Min.

1. Which of the following epithelial tissue functions as germinal epithelium to produce gametes?
(a) Simple ciliated epithelium
(b) Transitional epithelium
(c) Simple cuboidal epithelium
(d) Pseudostratified epithelium

2. Which of the following scientists studied different types of animal tissues including development of embryo and found that animal cells lack cell wall?
(a) Malthias Schleiden
(b) Theodore Schwann
(c) M. Schleiden and T. Schwann
(d) Rudolf Virchow

3. Skin dermis of large mammals yields leather after tanning due to the presence of
(a) white fibrous connective tissue
(b) yellow elastic connective tissue
(c) cartilage tissue
(d) dense irregular connective tissue.

4. The type of cartilage that occurs in the pubic symphysis that helps in parturition.
(a) Hyaline cartilage
(b) Yellow fibrous cartilage
(c) Calcified cartilage
(d) White fibrous cartilage

5. In a bacterial cell, glycocalyx perform several functions except
(a) protection from virus
(b) immunogenicity
(c) virulence
(d) helps in conjugation.

6. Which of the following is not concerned with excretion in animals?
(a) Yellow cells in earthworm
(b) Bidder's canal in frog
(c) Uricose glands in cockroach
(d) Phaosomes in earthworm

7. Mammalian bone is rich in
(a) calcium carbonate
(b) calcium floride
(c) calcium phosphate
(d) calcium chloride.

8. Match column I with column II and select the correct option from the given codes.

	Column I (Cell organelle)		**Column II (Function)**
A.	Endoplasmic reticulum	(i)	Synthesis of retinal pigment in chick embryo
B.	Golgi apparatus	(ii)	Synthesis of amino acids
C.	Lysosome	(iii)	Provides membrane to nuclear envelope after telophase
D.	Mitochondria	(iv)	Formation of thyroxine

(a) A-(iii), B-(i), C-(iv), D-(ii)
(b) A-(iii), B-(ii), C-(i), D-(iv)
(c) A-(i), B-(iii), C-(ii), D-(iv)
(d) A-(iv), B-(ii), C-(iii), D-(i)

9. In an eukaryotic cell, ______ is involved in expansion of cell wall through incorporation of more cellulose.
(a) pectin
(b) lignin
(c) suberin
(d) expansin

10. Read the following statements and select the correct option.
Statement A : Inner mitochondrial membrane contains number of particles.
Statement B : This membrane is permeable to most biochemicals.
(a) Statement A is correct but statement B is incorrect.
(b) Statement A is incorrect but statement B is correct.
(c) Both statements A and B are correct.
(d) Both statements A and B are incorrect.

11. Which of the following group of minerals/compounds is not found in blood plasma?
(a) Calcium, magnesium
(b) Sodium, potassium
(c) Nucleotides, amino acids
(d) Lysozyme, properdin

12. The epithelium found in the urinary system known as urothelium is a kind of
(a) stratified squamous epithelium
(b) transitional epithelium
(c) ciliated columnar epithelium
(d) stratified cuboidal epithelium.

13. Consider the following statements (i) – (iv) and select the correct option stating which ones are true (T) and which ones are false (F).
(i) In frogs, external ear is absent and only tympanum can be seen externally.
(ii) Nucleoplasm contains abundant minerals, amino acids nucleotide and sugar as compared to cytoplasm.
(iii) Desmosomes are supported by intermediate filaments called tonofibrils.
(iv) Malpighian tubules are present at the junction of midgut and hindgut in cockroaches.

	(i)	**(ii)**	**(iii)**	**(iv)**
(a)	T	F	T	T
(b)	F	F	T	T
(c)	T	T	F	F
(d)	F	T	F	F

14. Identify the cell organelle from the given characteristic features.

Site of photorespiration, site for break down of xenobiotics, presence of nucleoid, abundant in liver cells, presence of urate oxidase and D-amino acid oxidase.

(a) Glyoxysomes
(b) Chloroplast
(c) Peroxisomes
(d) Mitochondria

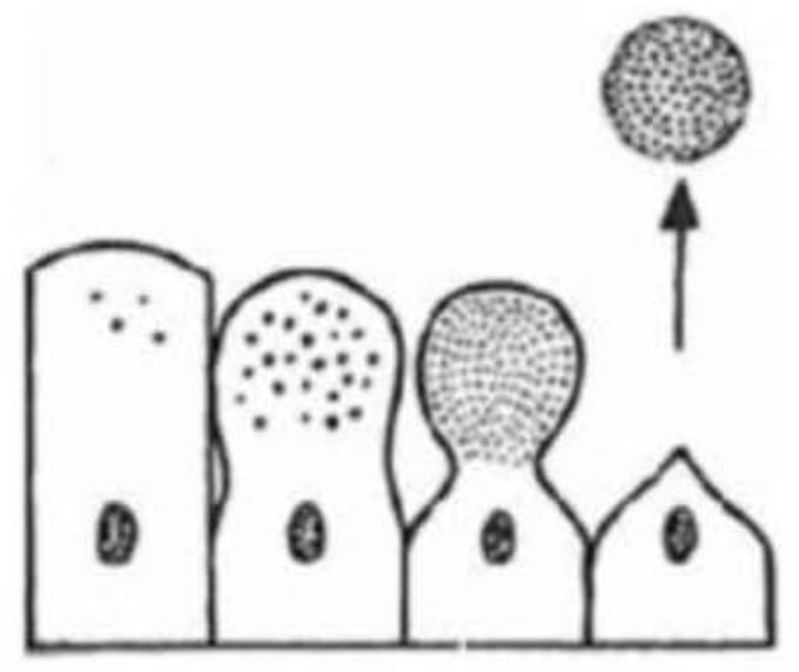
15. Match column I with column II and select the correct option from the given codes.

	Column I (Fat bodies)		**Column II (Functions)**
A.	Trophocytes	(i)	Concerned with intermediary metabolism at the time of ecdysis
B.	Mycetocytes	(ii)	Contain reserved food in the form of fats, glycogen and proteins
C.	Oenocytes	(iii)	Absorb nitrogenous waste product from haemolymph
D.	Urate cells	(iv)	Contain symbiotic bacteria for synthesis of some amino acid and vitamins

(a) A-(ii), B-(iv), C-(i), D-(iii)
(b) A-(i), B-(ii), C-(iii), D-(iv)
(c) A-(iii), B-(ii), C-(i), D-(iv)
(d) A-(iv), B-(ii), C-(iii), D-(i)

16. Centrosphere of centrosome is generally composed of
(a) a centriole, mitochondria and fibrous material
(b) a pair of centriole, mitochondria and fibrous material
(c) only fine fibrous material
(d) mitochondria and fibrous material.

17. Study the given figure and select the gland cell where such type of secretion occurs.



(a) Goblet cells
(b) Salivary glands
(c) Thyroid glands
(d) Mammary glands

INFOSHOT

Power Nap of Migratory Birds

It is fascinating to learn that sleep-loss of migratory birds during long distance travel is compensated by hundreds of power naps per day in mid-air. Although, each power nap is lasted for few seconds only. Scientists found that the frigate birds (*Fregata minor*) are indeed able to sleep in mid-air with one or both hemispheres of the brain and can enter into Rapid eye movement sleep (REM sleep) without dropping. REM sleep is a unique phase of sleep in mammals and birds, distinguishable by random/rapid movement of the eyes, accompanied with low muscle tone throughout the body. The birds can do this because they only sleep for a few minutes at a time and only for a few seconds when getting REM sleep. The birds used their ability to sleep one hemisphere at a time while their other eye and brain hemisphere remained open and active, keeping them semi-alert to danger. This is also called unihemispheric slow wave sleep (USWS). The ability of birds to switch from sleeping with both hemispheres simultaneously to sleeping with one hemisphere at a time developed in response to changing ecological demands. Hence, day time power nap is considered as behavioural adaptation in migratory birds.

18. Which of the following is not a major difference between primary and secondary cell wall?
(a) Difference in hydration
(b) Difference in protein content
(c) Difference in thickening
(d) Difference in glucose content

19. Matrix or stroma of chloroplast contains semifluid colloidal complex made up of
(a) 50% soluble proteins : 50% DNA, RNA, ribosomes, enzyme, etc.
(b) 70% soluble proteins : 30% DNA, plastoglobulin and enzymes, etc.
(c) 60% soluble proteins : 40% DNA, ribosome and plastoglobulin, etc.
(d) 40% soluble proteins : 60% enzymes, DNA, ribosomes, RNA, etc.

20. Read the given characteristics and identify the type of cartilages.

Characteristics	A	B	C
Elasticity	Flexible	Firm	Flexible
Colour	Bluish white	Glistening white	Yellowish
Location	Sternum	Pubic symphysis	Eustachian tubs

	A	B	C
(a)	White fibrous cartilage	Calcified cartilage	Elastic cartilage
(b)	Elastic cartilage	White fibrous cartilage	Hyaline cartilage
(c)	Elastic cartilage	Calcified cartilage	White fibrous cartilage
(d)	Hyaline cartilage	White fibrous cartilage	Elastic cartilage

21. In cockroach, male and female cannot be identified morphologically on the basis of
(a) boat-shaped 7th sternum in females
(b) broader abdomen in females
(c) 9 visible sterna in females
(d) genital pouch between 7th, 8th and 9th sternum in females.

22. Which of the following neuroglial cells acts as small macrophages?
(a) Macroglia cells (b) Microglial cells
(c) Astrocytes (d) Ependymal cells

23. The Ca^{+2} ions used during muscle contraction are released from
(a) Golgi apparatus
(b) rough endoplasmic reticulum
(c) nucleus
(d) smooth endoplasmic reticulum.

24. Read the given statements and select the correct option.
(a) In earthworm, the typhosole containing region lies in the last 23rd - 25th segments, mainly stores the faecal matter.
(b) In cockroach, a labroclypeal suture is present between frons and clypeus.
(c) Chloragogen cells in earthworm are analogous to the liver of vertebrates.
(d) The characteristic foul smell of cockroach is due to the stink glands present between 4th and 5th abdominal terga.

25. Bone is the hardest tissue of the body. What will happen if a bone is kept in a dilute HCl solution for some time?
(a) Organic part will dissolved
(b) Inorganic part will dissolved
(c) Only calcium carbonate will be left behind
(d) Only calcium phosphate will be left behind

26. Cell size and cell volume is not limited by
(a) nucleo-cytoplasmic ratio
(b) rate of metabolic activity
(c) ability of oxygen and other materials to reach every part of the cell
(d) division of labour in cells.

27. Which of the following statements hold true as evidence in support of fluid mosaic model?
(a) Use of freeze etching technique to confirm occurrence of particle over and inside membrane.
(b) Experimental evidence for lateral movement of membrane protein indicating fluidity of the lipid part.
(c) Explanation about the passage of both electrolytes and non-electrolytes through the biomembranes.
(d) All of these

IMPORTANT DAYS IN SEPTEMBER

September 5 : Teacher's Day (Dr. Radhakrishnan's Birthday)
September 8 : International Literacy Day
September 14 : Hindi Day and World's First Aid Day
September 15 : Engineer's Day
September 16 : World Ozone Day
September 21 : International Day of Peace and World Alzheimer's Day
September 25 : Antyodaya Diwas
September 26 : World Contraception Day
September 27 : World Tourism Day
September 28 : World Rabies Day
September 29 : World Heart Day

28. Match the following columns and select the correct option from the given codes.

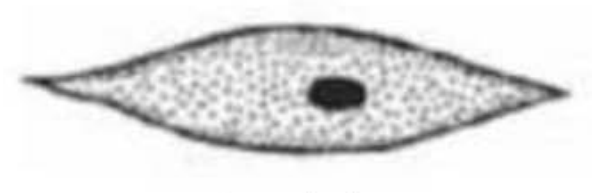
	Column I (Epithelium)		Column II (Location)
A.	Pseudostratified columnar ciliated	(i)	Nephrons of kidney
B.	Pseudostratified columnar	(ii)	Tympanic cavity of middle ear
C.	Ciliated cuboidal	(iii)	Trachea and large bronchi
D.	Ciliated columnar	(iv)	Parotid salivary glands

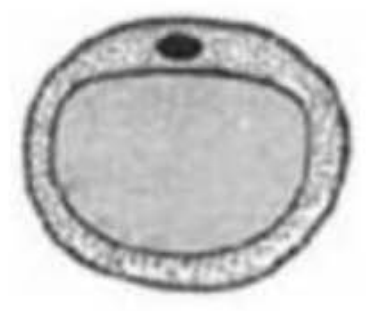
(a) A-(i), B-(ii), C-(iii), D-(iv)
(b) A-(iii), B-(iv), C-(i), D-(ii)
(c) A-(ii), B-(i), C-(iv), D-(iii)
(d) A-(iv), B-(iii), C-(i), D-(ii)

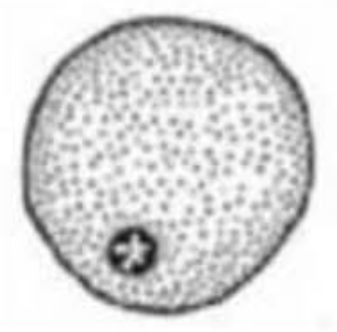
29. Inflammation of the bone marrow and adjacent bone and epiphysial cartilage is the characteristic of
(a) Paget's disease (b) osteomyelitis
(c) osteomalacia (d) osteomyelodysplasia.

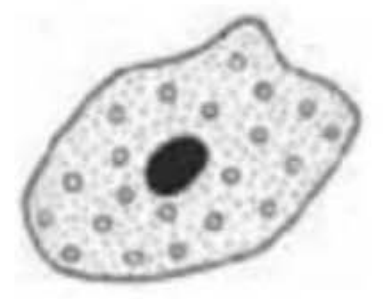
30. Which of the following cell organelles is responsible for production of hypnotoxin of nematoblasts?
(a) Endoplasmic reticulum
(b) Ribosome
(c) Golgi apparatus
(d) Mitochondria

31. Which of the following is also known as 'Cart Wheel Cell'?

(a)

Fibroblast

(b)

Adipose cell

(c)

Plasma cell

(d)

Mast cell

32. Which of the following is not a vagus nerve in frog?
(a) Palantine nerve (b) Gastric nerve
(c) Laryngeal nerve (d) Pulmonary nerve

33. Glands of Swammerdam and harderian glands are present in ______ and ______ of frogs respectively.
(a) ear, eye (b) eye, ear
(c) spinal cord, eye (d) eye, spinal cord

34. In prokaryotic cell, the plasmids that is associated temporarily with nucleoid are known as
(a) chondroid (b) episomes
(c) magnetosomes (d) metasomes.

35. Read the following statements with regard to frog and select the correct one.
(a) In frog, the characteristic feature of humerus is trochanter.
(b) Adrenal glands are present on the dorsal surface of each kidney.
(c) Frogs have four sense organs *viz.* tangoreceptors, olfactoreceptors, photoreceptors and statoacoustic receptor.
(d) The sperm produced by germinal epithelium of seminiferous tubules are passed into Bidder's canal and then carried to transverse collecting tubule.

36. Which of the following is not included in objection to the cell theory?
(a) Coenocytes in *Rhizopus*
(b) Bacteria and cyanobacteria do not have nucleus and membrane bound organelles
(c) RBCs and sieve tube cells
(d) Absence of totipotency in cells

37. Gram negative bacteria can be differentiated from Gram positive bacteria on the basis of
(a) susceptible to antibiotics
(b) absence of techoic acid
(c) absence of porins (d) more murein content.

38. Consider the given properties and identify the type of cell.

Spindle amphiastral, Localised Golgi apparatus, Burst if placed in hypotonic solution, Presence of centrioles

(a) Any prokaryotic cell (b) Typical plant cell
(c) Typical animal cell (d) All of these

39. The polysaccharide found in fungus is similar to
(a) plant cellulose (b) lignin is plants
(c) insect chitin (d) muramic acid in bacteria.

40. Find the correct match.
(a) Smooth endoplasmic reticulum – Vitellogenesis
(b) Rough endoplasmic reticulum – Synthesises serum protein
(c) Golgi apparatus – Role in osteogenesis
(d) Lysosome – Means of quick intracellular transport

◆

Key is published in this issue. Search now!☺

SELF CHECK

No. of questions attempted ……
No. of questions correct ……
Marks scored in percentage ……

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

ZOOM IN BIO

The syllabus for NEET is very vast which impedes students from acquiring indepth knowledge and covering the entire syllabus at the same time. An important topic for NEET is therefore presented here in elaborate form to enable students grasp the topic, analyse the type of questions and SCORE HIGH.

HUMAN BRAIN AND SPINAL CORD

The brain is an organised structure, divided into many components that serve specific and important functions. The brain and spinal cord are continuous structures, which together form the central nervous system (CNS). They are both protected by hard bony coverings-the brain is lodged in the cranium and the spinal cord runs mid-dorsally between the vertebral column. Both brain and spinal cord are covered by three protective membranes, called **meninges**. Both the brain and spinal cord are bathed in cerebrospinal fluid (CSF), which is continuously circulated through the cerebral ventricles, the cavity of the spinal cord and the sub-arachnoid space. It serves as a pad to cushion the CNS from shocks and mechanical injuries. The CSF also carries oxygen and nutrients from the blood to the neurons and neuroglia of the CNS.

Together, the brain and spinal cord act as the central control system of the body, receiving and interpreting sensory information from the rest of the body and sending back signals to glands and muscles for appropriate responses.

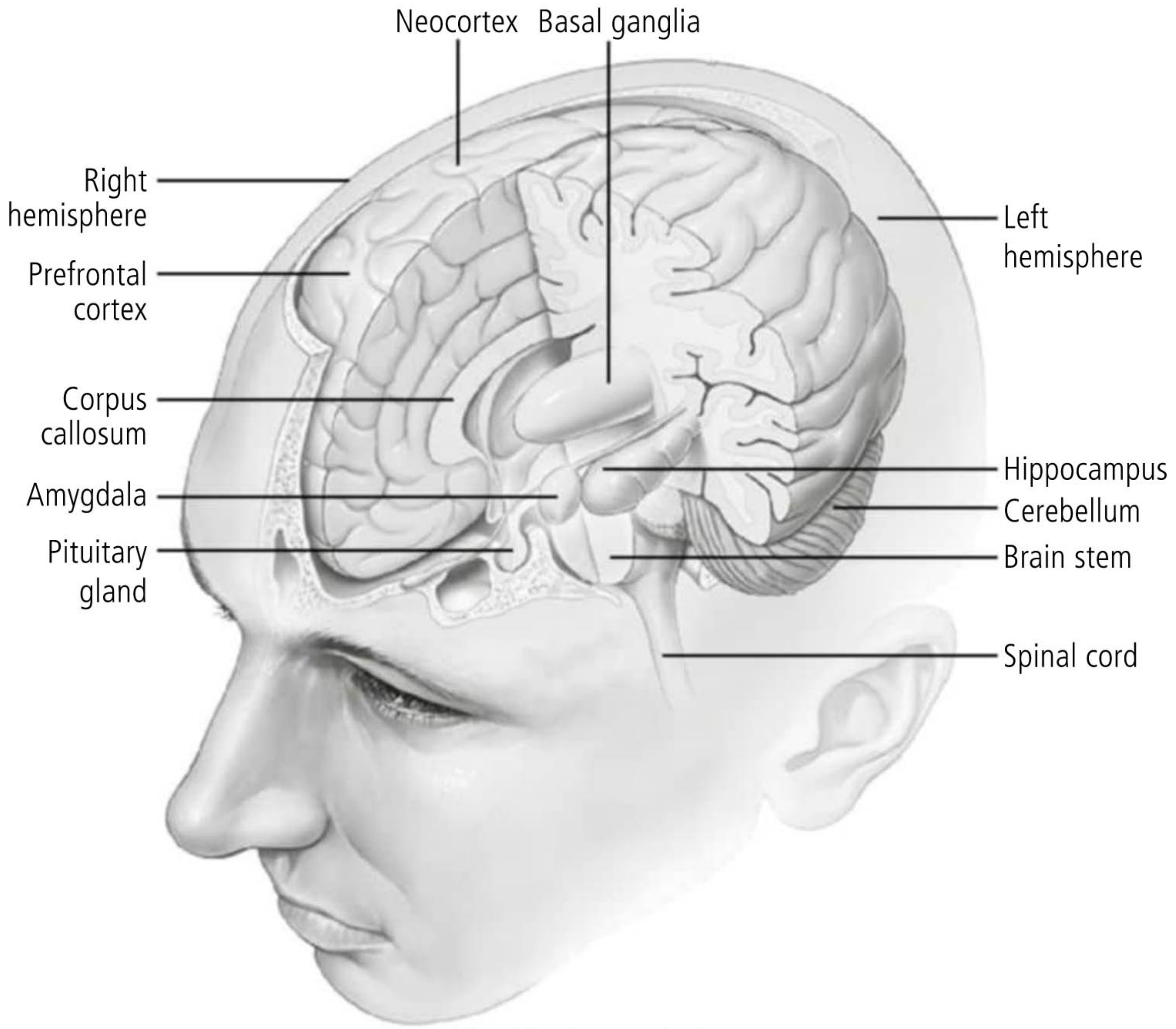


Fig.: The human brain

THE BRAIN

The human brain is the command centre for the human nervous system. It receives input from the sensory organs and sends output to the effectors. It processes and interprets sensory information sent from the spinal cord. The brain is caged inside the bony covering called the **cranium**. The cranium protects the brain from injury. Together, the cranium and bones that protect the face are called the **skull**. Between the skull and brain is the **meninges**, that consists of three layers of tissue which cover and protect the brain and spinal cord. From the outermost layer inward they are: the dura mater, arachnoid and pia mater.

Dura Mater : In the brain, the dura mater is made up of two layers of whitish, non-elastic film or membrane. The outer layer is called the **periosteum**. An inner layer, the dura, lines the inside of the entire skull and creates little folds or compartments in which parts of the brain are protected and secured. The two special folds of the dura in the brain are called the falx and the tentorium. The **falx** separates the right and left half of the brain and the **tentorium** separates the upper and lower parts of the brain *i.e.*, cerebrum from cerebellum and brain stem.

Arachnoid : Being the second layer of the meninges, this membrane is thin and delicate and covers the entire brain. There is a space between the dura and the arachnoid membranes that is called the **subdural space**. The arachnoid is made up of delicate, elastic tissue and blood vessels of varying sizes.

Pia Mater : The layer of meninges closest to the surface of the brain is called the pia mater. The pia mater has many blood vessels that reach deep into the surface of the brain. The pia mater, which covers the entire surface of the brain, follows the folds of the brain. The major arteries supplying the brain provide the pia with its blood vessels. The space that separates the arachnoid and the pia is called the **subarachnoid space**.

The brain is made up of two types of cells : **neurons** and **glial cells**, also known as neuroglia or glia. The neuron is responsible for sending and receiving nerve impulses or signals. Glial cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin and facilitate signal transmission in the nervous system. In the human brain, glial cells outnumber neurons by about 50 to one.

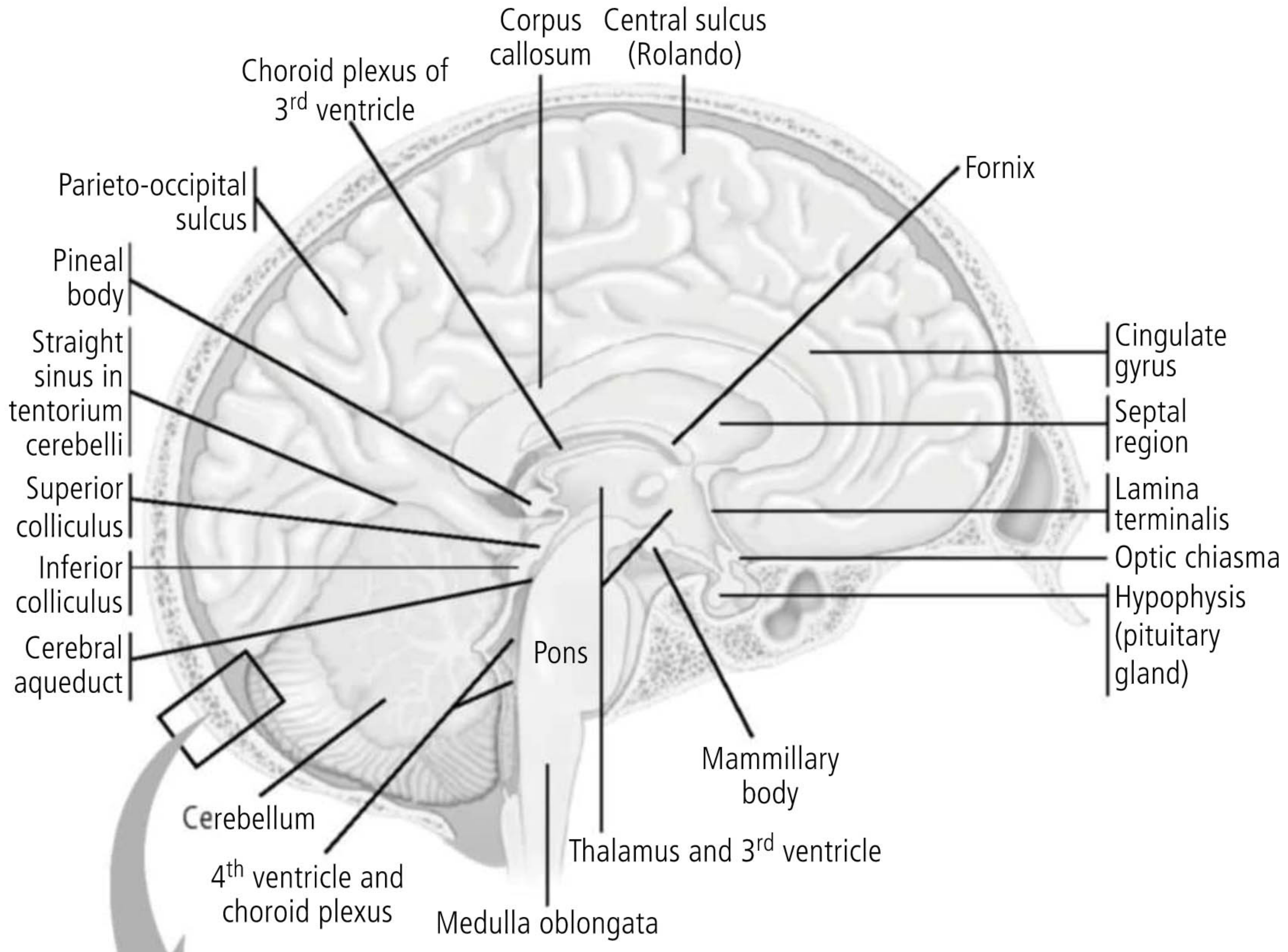


Fig.: Median section of human brain

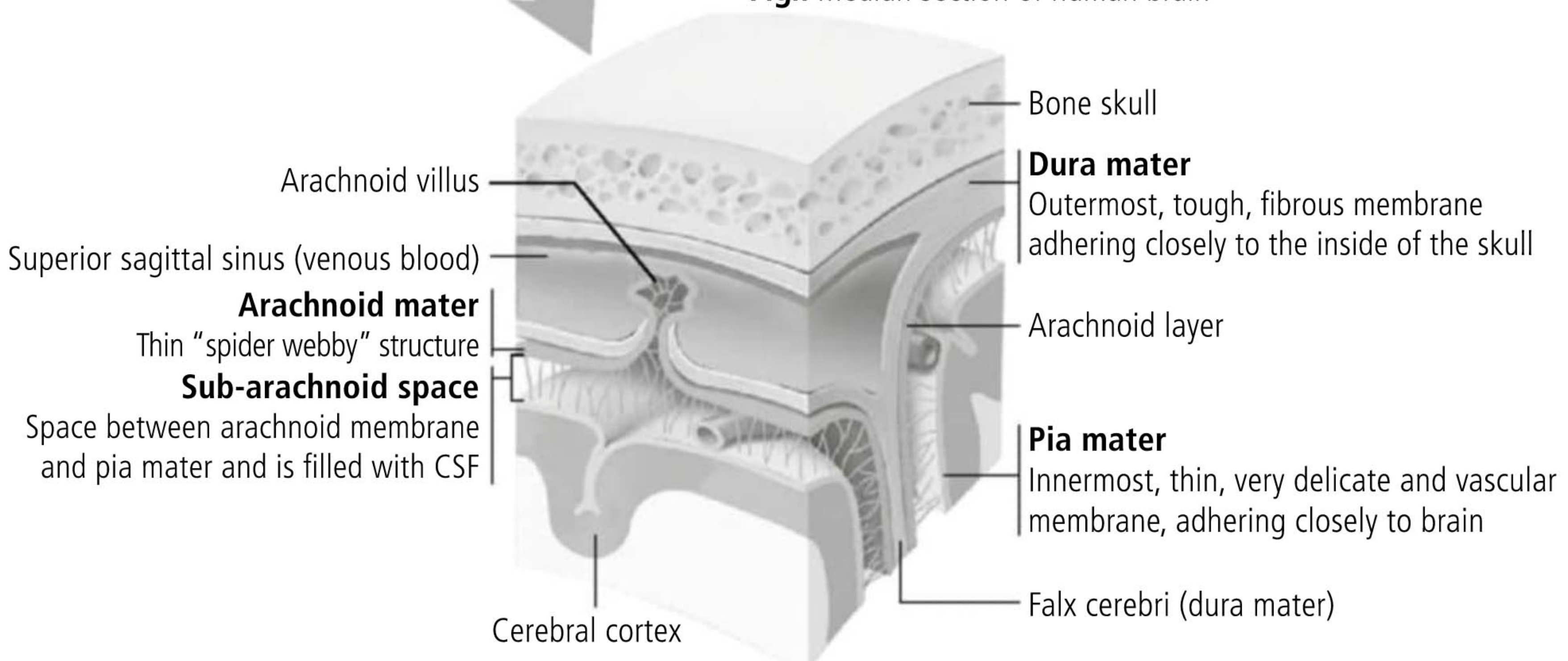

Bone skull
Arachnoid villus
Dura mater
Outermost, tough, fibrous membrane adhering closely to the inside of the skull
Superior sagittal sinus (venous blood)
Arachnoid mater
Thin "spider webby" structure
Arachnoid layer
Sub-arachnoid space
Space between arachnoid membrane and pia mater and is filled with CSF
Pia mater
Innermost, thin, very delicate and vascular membrane, adhering closely to brain
Falx cerebri (dura mater)
Cerebral cortex

Fig.: Meninges of brain

Brain can be divided into three parts - **forebrain** or **prosencephalon**, **midbrain** or **mesencephalon** and **hindbrain** or **rhombencephalon.**

Forebrain

Forebrain includes cerebrum and diencephalon.

Cerebrum

It is the largest and most complex part of human brain, consists of left and right hemispheres, connected by **corpus callosum** (large band of myelinated fibres). **Cerebral cortex** forms outermost portion of cerebrum and makes up the grey matter. The surface of cortex is highly folded, forming **gyri** (upward folds) alternating with **sulci** (downward grooves). This increases the area available for cortical neurons. The hemispheres are further divided into the 4 lobes; frontal, parietal, temporal and occipital. Each hemisphere receives sensory input from the opposite or contralateral side of the body and exerts motor control primarily over that side. Beneath the grey matter the part of the brain forms white matter. It contains million of medullated nerve fibres, connecting neurons of cerebral cortex with those located elsewhere in the brain. Large concentration of medullated nerve fibres gives an opaque white appearance.

Deep within the white matter of the cerebrum, there are several collections of cell bodies and dendrites that produce islands of grey matter. These aggregates of neuron cell bodies are collectively termed as **basal ganglia**. Basal ganglia participate in the control of body movements. Damage to specific regions of the basal ganglia can produce the resting tremor of muscles that is characteristic of people with Parkinson's disease.

Snap Shots

- In human brain, the cerebral cortex contains over 10 billion nerve cells, amounting to roughly 10% of all the neurons in the brain.
- The surface of the cerebral cortex is highly convoluted which increase the surface area of the cortex threefold.
- The portion of the cerebral cortex that is not occupied by the motor and sensory cortices, is referred to as association cortex. It is responsible for higher mental activities, involved in memory, learning and reasoning.

Cerebral Lobes

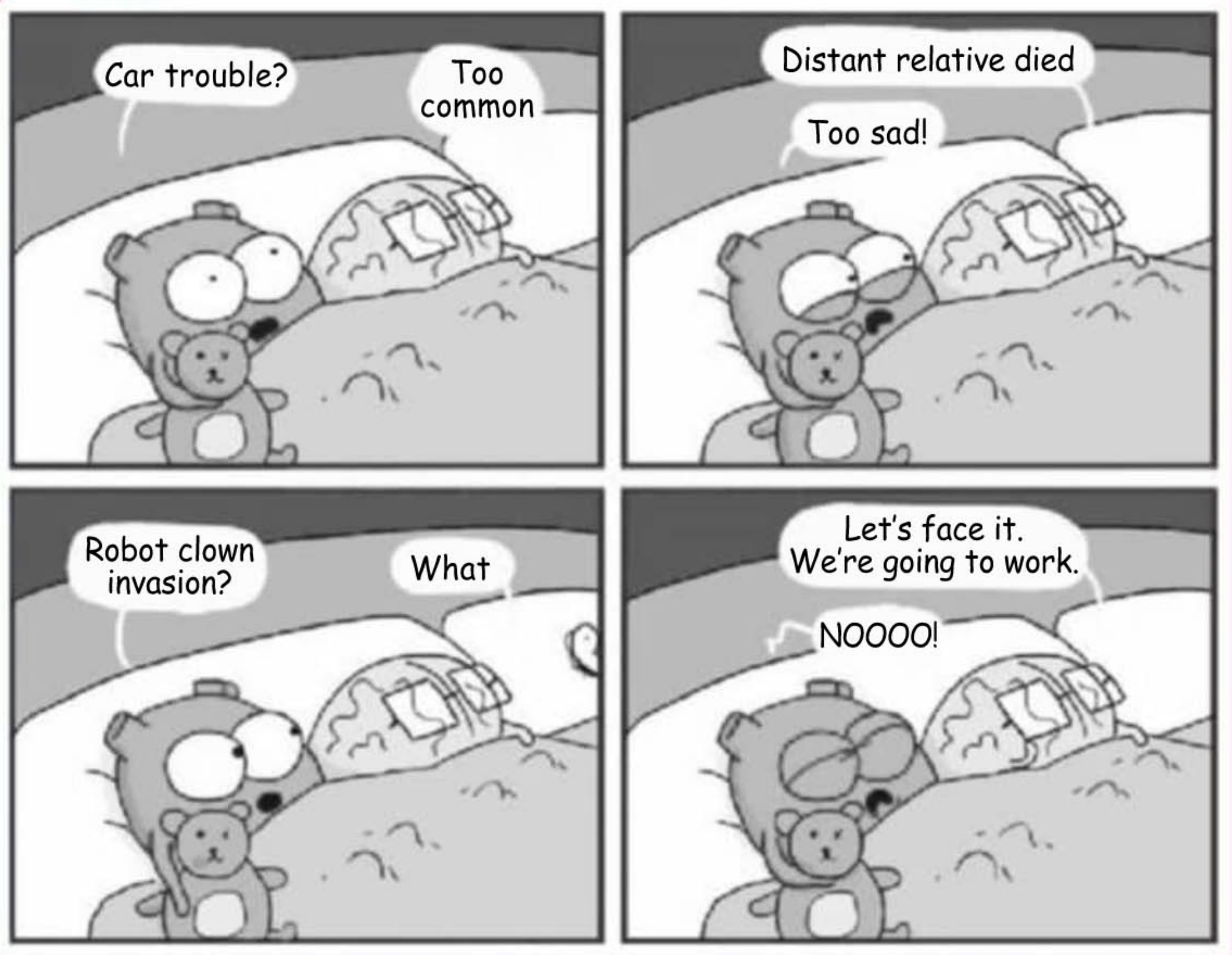
Frontal lobe

The frontal lobes are the largest of the four lobes responsible for many different functions. These include motor skills such as voluntary movement, speech, intellectual and behavioral functions. The areas that produce movement in parts of the body are found in the primary motor cortex or precentral gyrus. The prefrontal cortex plays an important role in memory, intelligence, concentration, temper and personality.

Occipital lobes

These lobes are located at the back of the brain and enable humans to receive and process visual information. They influence how humans process colors and shapes. The occipital lobe on the right interprets visual signals from the left visual space, while the left occipital lobe performs the same function for the right visual space.

COMIC CAPSULE


Car trouble?
Too common
Distant relative died
Too sad!
Robot clown invasion?
What
Let's face it. We're going to work.
NOOOO!

Parietal lobes

These lobes interpret, signals regarding sensory perception of touch, pain,heat and cold. A person's memory and the new sensory information is received and communicated to rest of brain and give meaning to objects.

Temporal lobes

These lobes are located on each side of the brain at about ear level and can be divided into two parts. One part is on the bottom (ventral) of each hemisphere and the other part is on the side (lateral) of each hemisphere. An area on the right side is involved in visual memory and helps humans recognise objects and peoples' faces. An area on the left side is involved in verbal memory and helps humans remember and understand language. The rear of the temporal lobe enables humans to interpret other people's emotions and reactions.

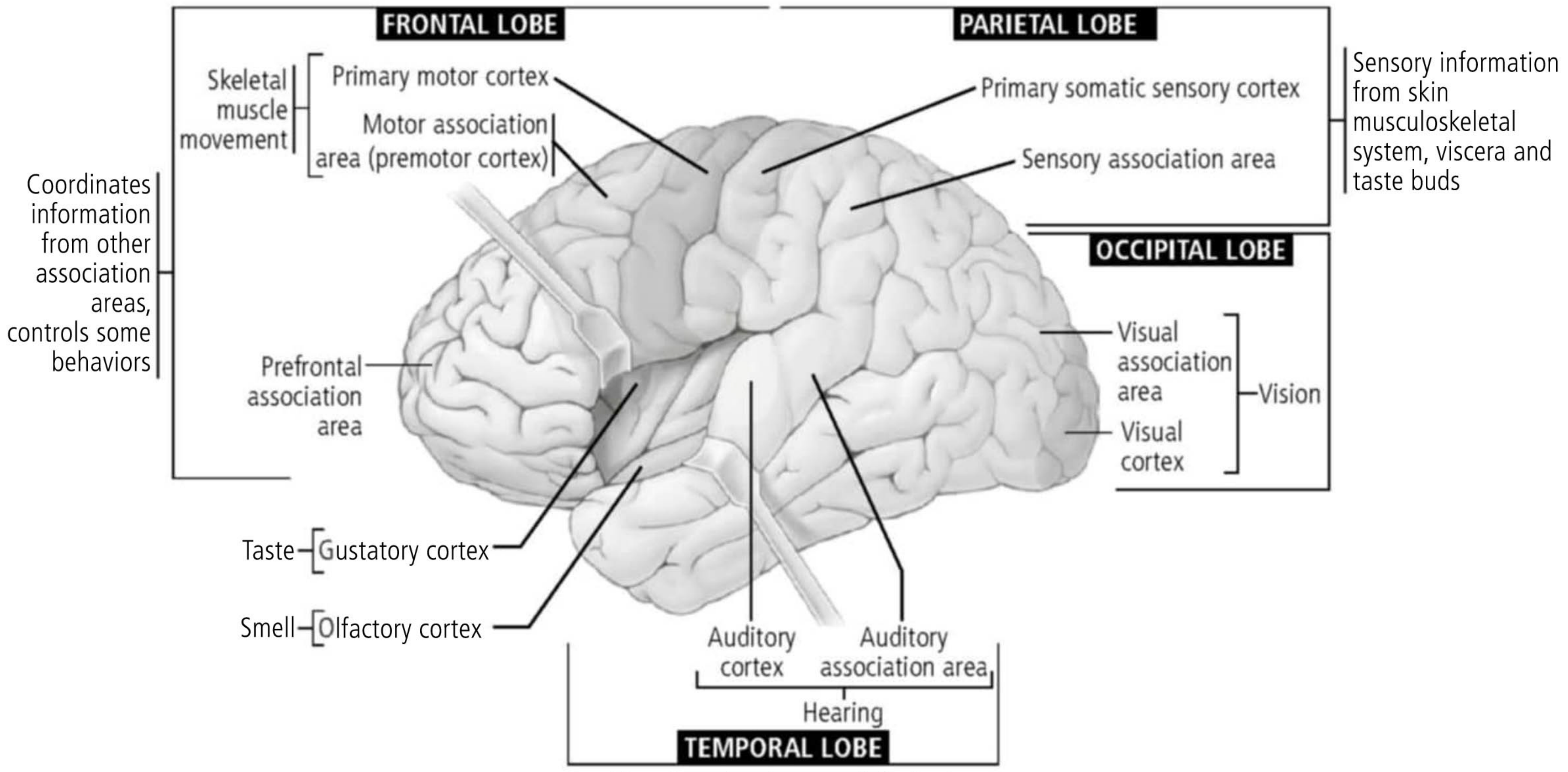

FRONTAL LOBE
Skeletal muscle movement
Primary motor cortex
Motor association area (premotor cortex)
Coordinates information from other association areas, controls some behaviors
Prefrontal association area
PARIETAL LOBE
Primary somatic sensory cortex
Sensory association area
Sensory information from skin musculoskeletal system, viscera and taste buds
OCCIPITAL LOBE
Visual association area
Visual cortex
Vision
Taste
Gustatory cortex
Smell
Olfactory cortex
Auditory cortex
Auditory association area
Hearing
TEMPORAL LOBE

Fig.: Functional areas of the brain

Diencephalon

It has three parts - epithalamus, thalamus and hypothalamus.

Epithalamus	Thalamus	Hypothalamus
• Forms anterior choroid plexus. • Short pineal stalk, have pineal body, secretes hormone **melatonin**.	• Lies superior to midbrain. • Composed primarily of grey matter.	• Lies above the pituitary gland and is attached to it by stalk called **infundibulum.** • Maintains homeostasis, provides anatomical connections between nervous and endocrine systems.

Midbrain

It is divided into two parts by Aqueduct of Sylvius; the duct which connects IIIrd ventricle in the midbrain with the IVth ventricle in the pons and medulla.

(i) **Corpora quadrigemina**

- 2 pairs of rounded protrusions present on upper or superior surface of midbrain are called corpora quadrigemina.
- One pair is called **superior colliculi** (concerned with sense of sight) and other pair is **inferior colliculi** (concerned with hearing).
- The superior and inferior colliculi of each side are termed as **corpora bigemina**.

(ii) **Cerebral peduncles (Crura cerebri)**

- These are two bundles of fibres present on lower or inferior surface of the mid brain.
- They relay impulses back and forth between the cerebrum, cerebellum, pons and medulla.

Hindbrain

Hindbrain consists of cerebellum, pons varolii and medulla oblongata.

Cerebellum

It is the second largest part of the human brain, consists of 3 layers, outer layer of cells, cerebellar cortex and deeper cell clusters. Middle layer contains characteristically large flask shaped **Purkinje cells**. Cerebellum has two lateral **cerebellar hemispheres** and central worm shaped part, **vermis.** Cerebellum contains branching tree-like arrangement of grey and white matter called **arbor vitae** (tree of life). It controls posture, balance and mainly involuntary activities, receives information from muscles, joints, skin and eyes.

Pons Varolii

It is situated in front of cerebellum below the midbrain and above the medulla oblongata. It relays impulses between the medulla oblongata and superior part of brain, between hemispheres of cerebellum and between cerebrum and cerebellum. Pneumotaxic centre present in pons varolii limits inspiration.

Medulla Oblongata

It is pyramid shaped, extends from pons varolii above and is continuous with spinal cord below. It has thin, non-vascular folded structure on its lower side called posterior choroid plexus. Regulatory centres for heart rate, blood pressure, breathing, sneezing, salivation, coughing, etc.

The mid brain, pons varolii and medulla oblongata are collectively called brain stem, connecting forebrain with spinal cord.

Snap Shots

- Human brain continues to develop through early childhood, but no new neurons are produced once development has ceased, except in the tiny hippocampus.
- Hippocampus controls which experiences are filed away into long-term memory and which has to be forgotten.

Emotional Brain

- – Limbic system is also known as emotional brain. It consists of certain components of cerebrum and diencephalon.
- – Main components are - (i) Hippocampus (ii) Amygdala (iii) Septal nuclei (iv) Mamillary bodies (v) Basal ganglia.
- – It controls emotional behaviour, food habits and sex behaviour necessary for survival of species.

Ventricles of the Brain: Within the central nervous system is a system of hollow cavities called ventricles. The network of linked cavities in the brain (cerebral ventricles) is continuous with the central canal of the spinal cord. The ventricles are filled with cerebrospinal fluid which is produced by specialised epithelium located within the ventricles called the **choroid plexus.**

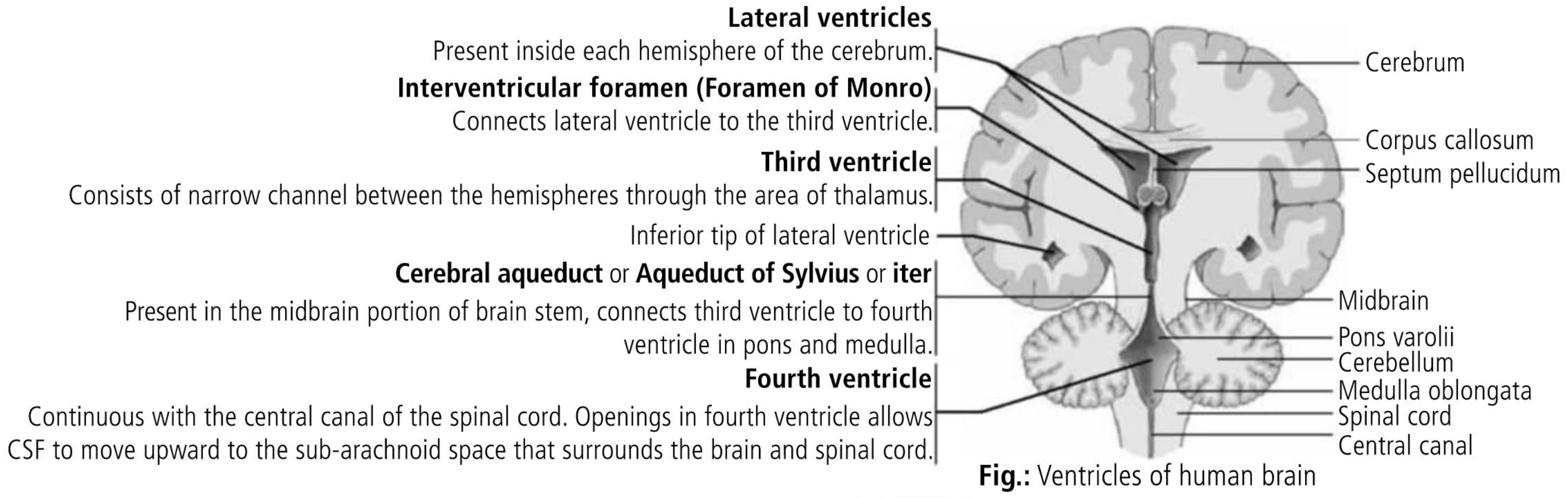

Lateral ventricles
Present inside each hemisphere of the cerebrum.
Interventricular foramen (Foramen of Monro)
Connects lateral ventricle to the third ventricle.
Third ventricle
Consists of narrow channel between the hemispheres through the area of thalamus.
Inferior tip of lateral ventricle
Cerebral aqueduct or **Aqueduct of Sylvius** or **iter**
Present in the midbrain portion of brain stem, connects third ventricle to fourth ventricle in pons and medulla.
Fourth ventricle
Continuous with the central canal of the spinal cord. Openings in fourth ventricle allows CSF to move upward to the sub-arachnoid space that surrounds the brain and spinal cord.
Cerebrum
Corpus callosum
Septum pellucidum
Midbrain
Pons varolii
Cerebellum
Medulla oblongata
Spinal cord
Central canal

Fig.: Ventricles of human brain

CEREBROSPINAL FLUID (CSF)

Cerebrospinal fluid (CSF) is found within the brain and surrounds the brain and the spinal cord. It is a clear, watery substance that helps to cushion the brain and spinal cord from injury. This fluid circulates through channels around the spinal cord and brain, constantly being absorbed and replenished. It is within hollow channels in the brain, called ventricles, that the fluid is produced. A specialised structure within each ventricle, called the **choroid plexus**, is responsible for the majority of CSF production. The brain normally maintains a balance between the amount of CSF that is absorbed and the amount that is produced. However, disruptions in this system may occur.

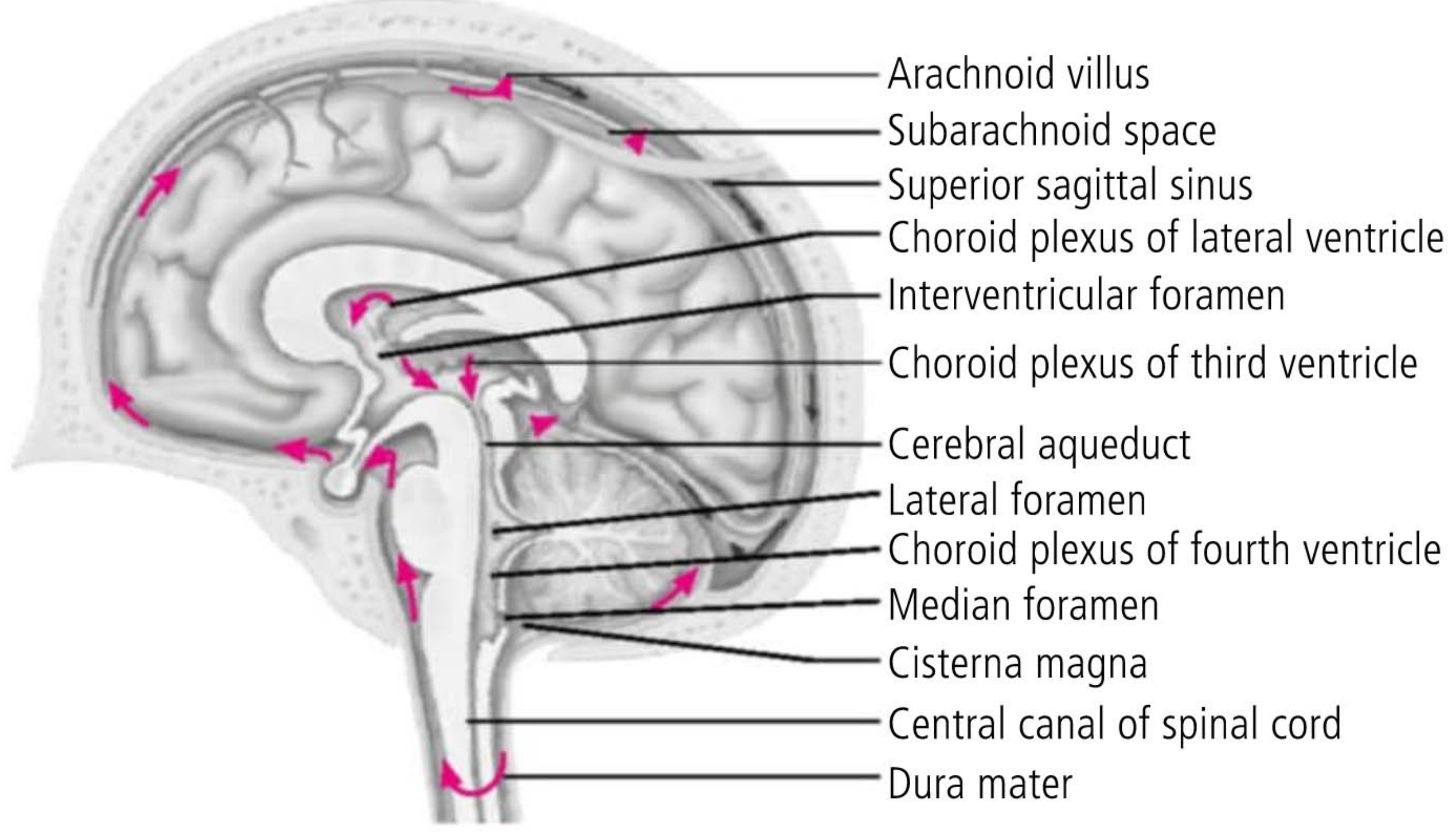


Fig.: Circulation of cerebrospinal fluid

Functions of CSF

- **Protection of brain and spinal cord** by providing shock absorbing medium.
- **Provides buoyancy to the brain**, as brain is immersed in the CSF.
- **Excretion-** CSF carries harmful metabolic wastes, drugs and other substances from brain to the blood.
- **Endocrine medium for the brain** - CSF carries hormones to different parts of the brain.

THE SPINAL CORD

Spinal cord is a cylindrical shaped bundle of nerve fibres that is connected to the brain. It runs down mid-dorsally, in the centre of the protective spinal column extending from the neck to the lower back. It lies in the neural canal of veretebral column. Inside the spinal cord there are two zones. The inner zone called grey matter, consists of interneurons and the cell bodies of motor neurons. The outer zone called white matter, contains the axons and dendrites of nerve cells. Spinal cord nerves transmit information from body organs and external stimuli to the brain and send information from the brain to other areas of the body.

Covering Meninges - The spinal cord is surrounded by three protective membranes; innermost **pia mater**, middle **arachnoid membrane** and outer, tough **dura mater.** The sub-arachnoid space is filled with cerebrospinal fluid and the additional **epidural space,** above dura mater contains fatty and connective tissues and veins.

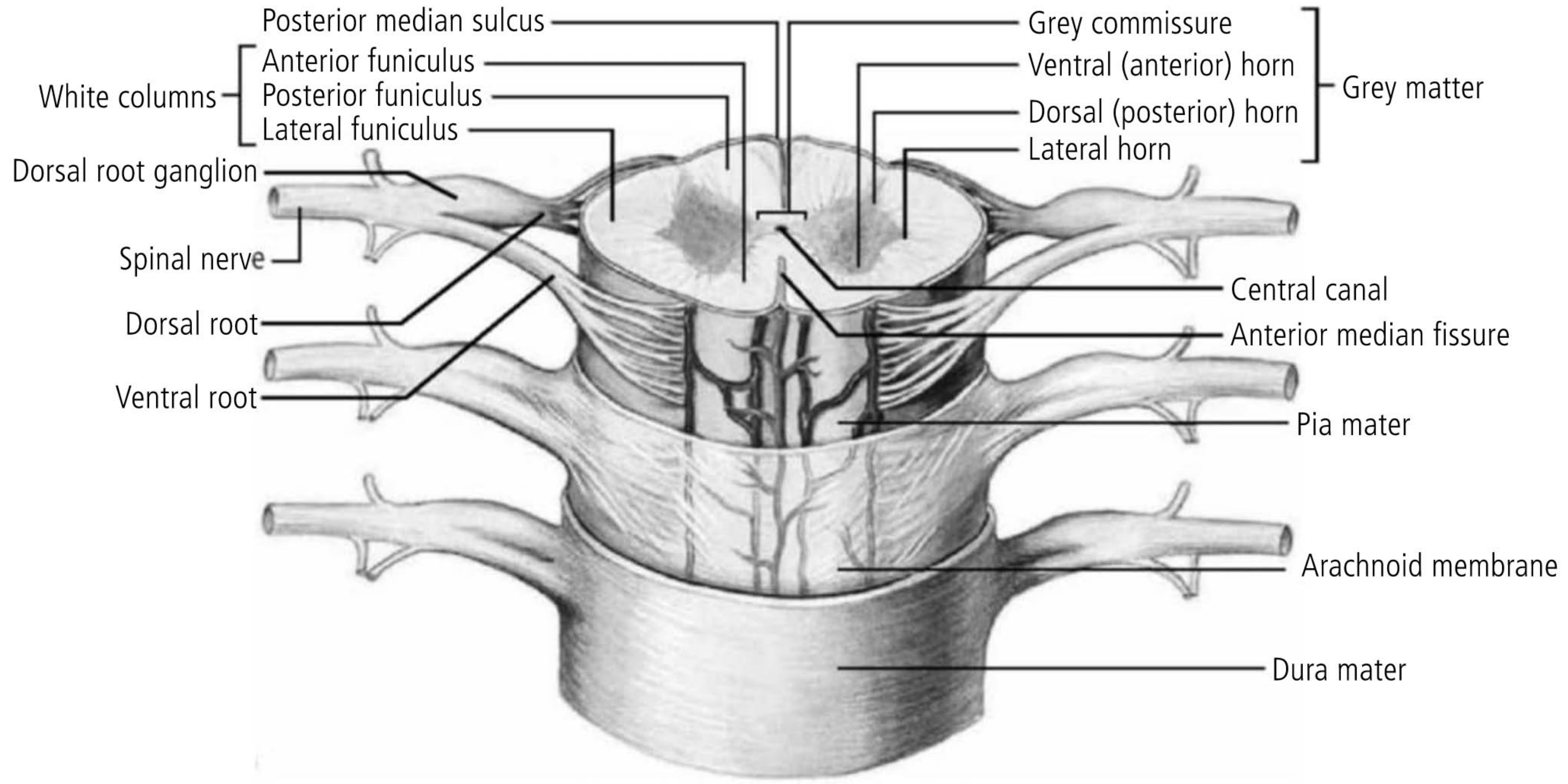


Fig. : Coverings of human spinal cord

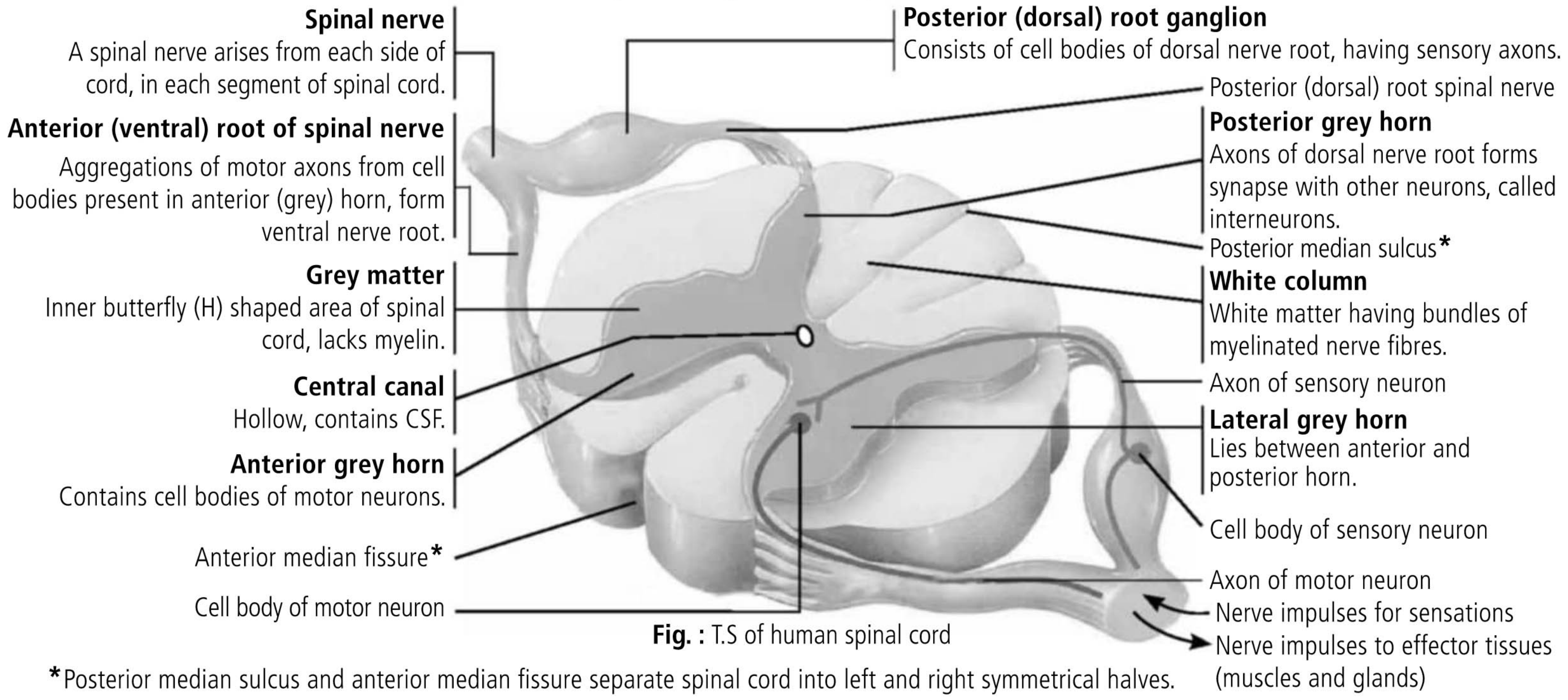

Spinal nerve
A spinal nerve arises from each side of cord, in each segment of spinal cord.
Anterior (ventral) root of spinal nerve
Aggregations of motor axons from cell bodies present in anterior (grey) horn, form ventral nerve root.
Grey matter
Inner butterfly (H) shaped area of spinal cord, lacks myelin.
Central canal
Hollow, contains CSF.
Anterior grey horn
Contains cell bodies of motor neurons.
Anterior median fissure*
Cell body of motor neuron
Posterior (dorsal) root ganglion
Consists of cell bodies of dorsal nerve root, having sensory axons.
Posterior (dorsal) root spinal nerve
Posterior grey horn
Axons of dorsal nerve root forms synapse with other neurons, called interneurons.
Posterior median sulcus*
White column
White matter having bundles of myelinated nerve fibres.
Axon of sensory neuron
Lateral grey horn
Lies between anterior and posterior horn.
Cell body of sensory neuron
Axon of motor neuron
Nerve impulses for sensations
Nerve impulses to effector tissues (muscles and glands)

Fig. : T.S of human spinal cord

*Posterior median sulcus and anterior median fissure separate spinal cord into left and right symmetrical halves.

Functions of spinal cord

It performs two main functions:

(i) The stimuli are passed from and to the brain through the spinal cord.

(ii) It is the centre of spinal reflex action.

Snap Shots

- The spinal cord extends from medulla oblongata and is continuous to the level of second lumbar vertebra.
- The spinal cord is divided into four different regions - cervical, thoracic, lumbar and sacral regions. The different cord regions can be visually distinguished from one another.
- The atrial blood supply to the spinal cord in the upper cervical regions is derived from two branches of the vertebral arteries- the anterior spinal artery and the posterior spinal arteries.

There are cranial nerves which emerge directly from the brain. In contrast, spinal nerves emerge from segments of the spinal cord.

CRANIAL NERVES

There are 12 pairs of cranial nerves. They are so named because they pass through various openings in the cranial bones.

Table: Types of cranial nerves

	Name	Origin	Distribution	Nature	Functions
I.	Olfactory	Olfactory epithelium in nasal cavity	Olfactory lobe or bulb	Sensory	Smell
II.	Optic	Retina of eye	Optic lobe of midbrain	Sensory	Sight
III.	Oculomotor	Floor of midbrain	Eye, 4 muscles of eyeball	Motor	Movements of eye-ball, iris, lens, eyelid and constriction of pupil
IV.	Trochlear **(Thinnest and smallest cranial nerve)**	Floor of midbrain	Superior oblique muscles of eyeball	Motor	Rotation of eyeball
V.	Trigeminal **(Largest cranial nerve)** Divided into three branches:	Ventral surface of pons varolii		Mixed	
	(a) Opthalmic		– Lacrimal glands, conjunctiva of eye, skin of forehead, eyelids, etc.	Sensory	Skin sensations
	(b) Maxillary		– Cheeks, upper gums, upper teeth and lower eyelids	Sensory	Sensations
	(c) Mandibular **(Largest branch)**		– Teeth and gums of lower jaw, pinna of the ear, lower lip and tongue	Mixed	Sensations, tongue movements, mastication
VI	Abducens	Pons varolii	Lateral rectus muscle of eyeball	Motor	Rotation of eyeball
VII	Facial (bears geniculate ganglion)	Lower part of pons varolii	Anterior 2/3 tongue (taste buds), muscles of face, neck and salivary glands.	Mixed	Taste, facial expression, chewing, movement of neck
VIII	Auditory (also called vestibulo-cochlear)	Comes from internal ear and joins lateral side of pons varolii	Organ of Corti in cochlea, semicircular canals	Sensory	Hearing and equilibrium
IX	Glosso-pharyngeal	Lateral side of medulla	Posterior 1/3rd of tongue, soft palate and muscles of pharynx	Mixed	Taste and touch, movements (swallowing) of pharynx, salivation
X	Vagus (Pneumogastric) **(Longest cranial nerve)** (a) Superior laryngeal (b) Recurrent laryngeal (c) Cardiac (d) Pneumogastric (e) Depressor	Lateral side and floor of medulla	Muscles of pharynx, vocal cords, lungs, heart, oesophagus, stomach. **Also called wandering nerve as it has maximum branches**.	Mixed	Vocal cords (sound production), lungs, respiratory reflexes, peristaltic intestine movements, speech, swallowing, secretion of gastric glands, inhibition of heart beat
XI	Accessory nerves	Both medulla oblongata and spinal cord	Muscles of palate, larynx, vocal cords, neck, shoulder	Motor	Movement of muscles of pharynx, larynx, neck, shoulder
XII	Hypoglossal	Ventral side of medulla oblongata	Muscles of tongue, hyoid apparatus	Motor	Movement of tongue

All cranial nerves are situated in the brain stem. For example:-

(i) in the midbrain – III and IV nerves, (ii) in the pons – V, VI, VII and VIII nerves (iii) in the medulla – IX, X, XI and XII nerves

SPINAL NERVES

There are 31 pairs of spinal nerves, named and numbered according to the vertebrae with which they are associated.

31 pairs of spinal nerves

Cervical nerves	Thoracic nerves	Lumbar nerves	Sacral nerves	Coccygeal nerves
(8 pairs)	(12 pairs)	(5 pairs)	(5 pairs)	(1 pair)

Structure - The spinal nerves are formed by union of dorsal and ventral roots shortly after they leave spinal cord. Each spinal nerve has afferent (sensory) and efferent (motor) fibres, in general, efferent comes from ventral root and afferent go into dorsal root. Thus, all spinal nerves are **mixed nerves** because they carry both sensory and motor impulses.

– After passing through inter vertebral foramen, each spinal nerve divides into:

Posterior branch- innervates muscles and skin of the posterior portion of the body.

Anterior branch- innervates limbs and the lateral and anterior portions of the body.

Spinal nerves join to form the following plexuses :

Coccygeal plexus	Cervical plexus	Brachial plexus	Lumbar plexus	Sacral plexus
Innervates skin and pelvic region	Innervates neck and diaphragm	Innervates chest and arm	Innervates the legs	Connects pelvic region

POWER EXERCISE

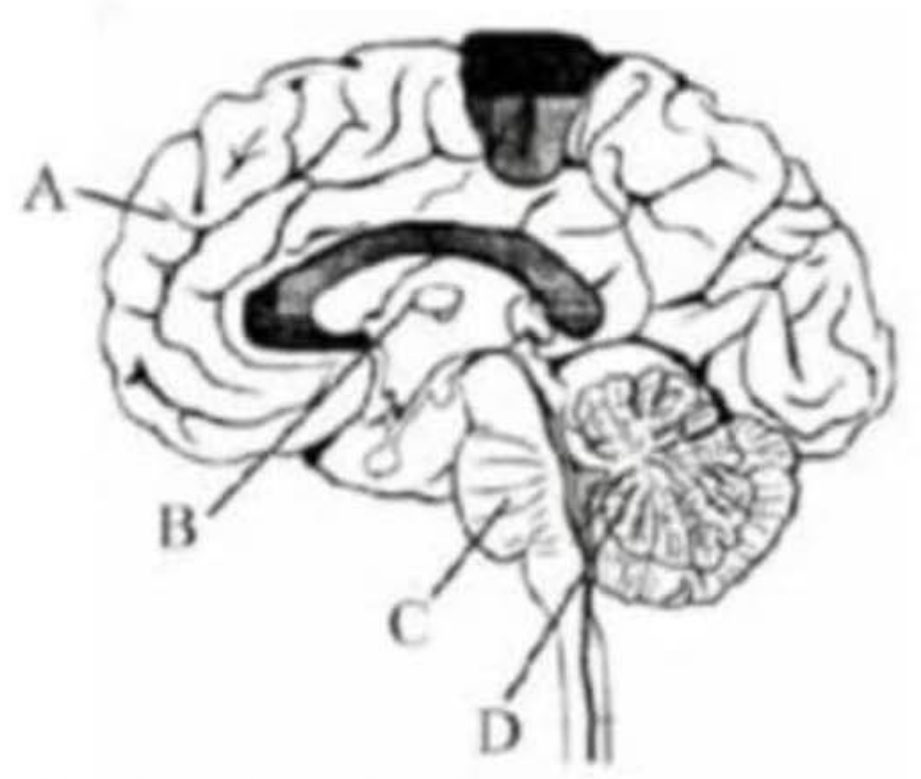
1. Select the correct sequence of meninges from outer to inner side.
   (a) Duramater ⟶ Piamater ⟶ Arachnoid mater
   (b) Piamater ⟶ Arachnoid mater ⟶ Duramater
   (c) Duramater ⟶ Arachnoid mater ⟶ Piamater
   (d) Arachnoid mater ⟶ Duramater ⟶ Piamater

2. Select the mismatched pair.
   (a) Wernicke's area – Understanding speech and writing words
   (b) Sensory speech area – Perceives the spoken word
   (c) Auditory area – Hearing
   (d) Post central area – Initiates the contraction of voluntary muscles

3. Select the incorrect statement.
   (a) Cerebral cortex makes up the grey matter, while white matter is located deep.
   (b) White matter is white in colour due to presence of fatty myelin sheath.
   (c) In the spinal cord, inner butterfly shaped area forms white matter.
   (d) In brain grey matter comprises of cell bodies, dendrites and synapses of neurons.

4. Which part of the brain is mainly concerned with intelligence and memory?
(a) Cerebrum (b) Cerebellum
(c) Hypothalamus (d) Medulla oblongata

5. A sagittal section of human brain is shown here. Identify at least two labels from A-D.



(a) C-Midbrain, D-Cerebellum
(b) A-Cerebrum, C-Pons
(c) B-Corpus callosum, D-Medulla
(d) A-Cerebral hemisphere, B-Cerebellum

(NEET Karnataka 2013)

6. Largest cranial nerve in humans is
(a) trochlear nerve (b) oculomotor nerve
(c) trigeminal nerve (d) ophthalmic nerve.

7. Select the group of spinal nerves that are collectively called 'cauda equina' or 'horse's tail'.
(a) Cervical, coccygeal and thoracic
(b) Lumbar, sacral and coccygeal
(c) Thoracic, cervical and sacral
(d) Sacral, coccygeal and cervical

8. Pneumotaxic centre is present in
(a) pons varolii (b) hypothalamus
(c) medulla oblongata (d) brain stem.

9. Which of the following statements are true for "limbic system"?
(i) Amygdala is almond shaped and is located inside the temporal lobe.
(ii) Limbic system is also called the "emotional brain".
(iii) Basal ganglia are scattered masses of grey matter.
(iv) Certain components of cerebellum and diencephalon constitute the limbic system.
(v) Septal nucleic are formed by the regions under corpus callosum and the paraterminal gyrus.
(a) (i), (ii) and (iii) (b) (i), (iii) and (v)
(c) (ii), (iii) and (iv) (d) (ii), (iii) and (v)

10. Destruction of the anterior horn cells of the spinal cord would result in loss of
(a) commissural impulses (b) integrating impulses
(c) sensory impulses (d) voluntary motor impulses.

(AIPMT 2015)

11. Match the following columns I and II and select the correct option from the given codes.

	Column I (Cerebral lobes)	**Column II (Functions)**
A.	Temporal lobe	(i) Decodes and interprets visual information
B.	Parietal lobe	(ii) Decodes and interprets sound, language and memory
C.	Occipital lobe	(iii) Registers sensory perception of touch, pain, heat and cold
D.	Frontal lobe	(iv) Controls intellectual ability

(a) A-(iii), B-(ii), C-(i), D-(iv) (b) A-(ii), B-(iii), C-(i), D-(iv)
(c) A-(ii), B-(iii), C-(iv), D-(i) (d) A-(ii), B-(i), C-(iii), D-(iv)

12. Function of superior colliculi of corpora quadrigemina is
(a) to relay impulses between cerebrum and cerebellum.
(b) to interpret auditory impulses
(c) to regulate sense of sight
(d) to regulate heart beat.

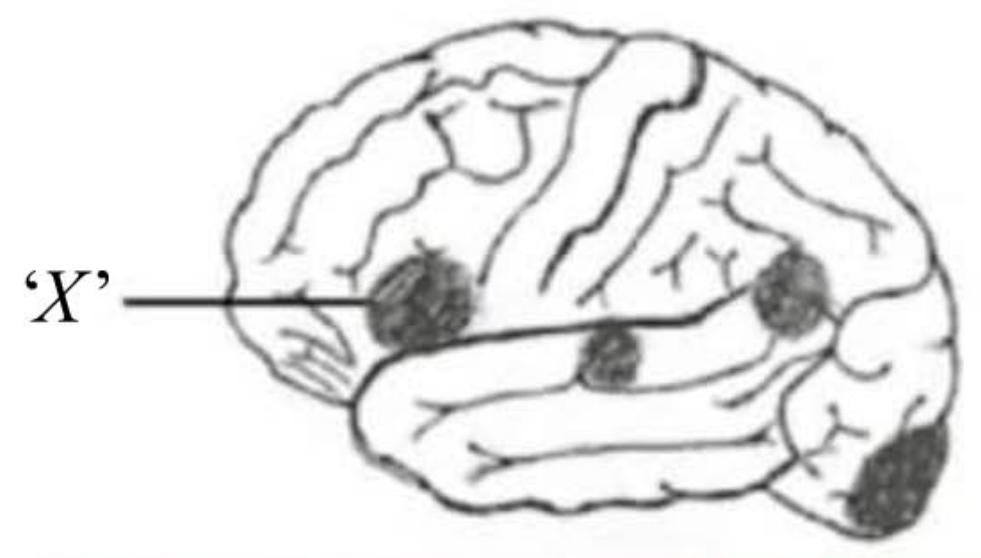
13. The body temperature regulatory centre in the brain is
(a) cerebellum (b) corpus callosum
(c) hypothalamus (d) hippocampus
(e) amygdala.

(Kerala PMT 2015)

14. The II, IV, VI and XI cranial nerves are respectively
(a) trochlear, oculomotor, olfactory and optic
(b) optic, trochlear, oculomotor and accessory
(c) olfactory, trochlear, accessory and abducens
(d) optic, trochlear, abducens and accessory.

15. The membranous areas between the cranial bones of the fetal skull are called________.
(a) sulci (b) splenium
(c) fontanels (d) genu

16. The functional area of human cerebrum marked by 'X' is ________.



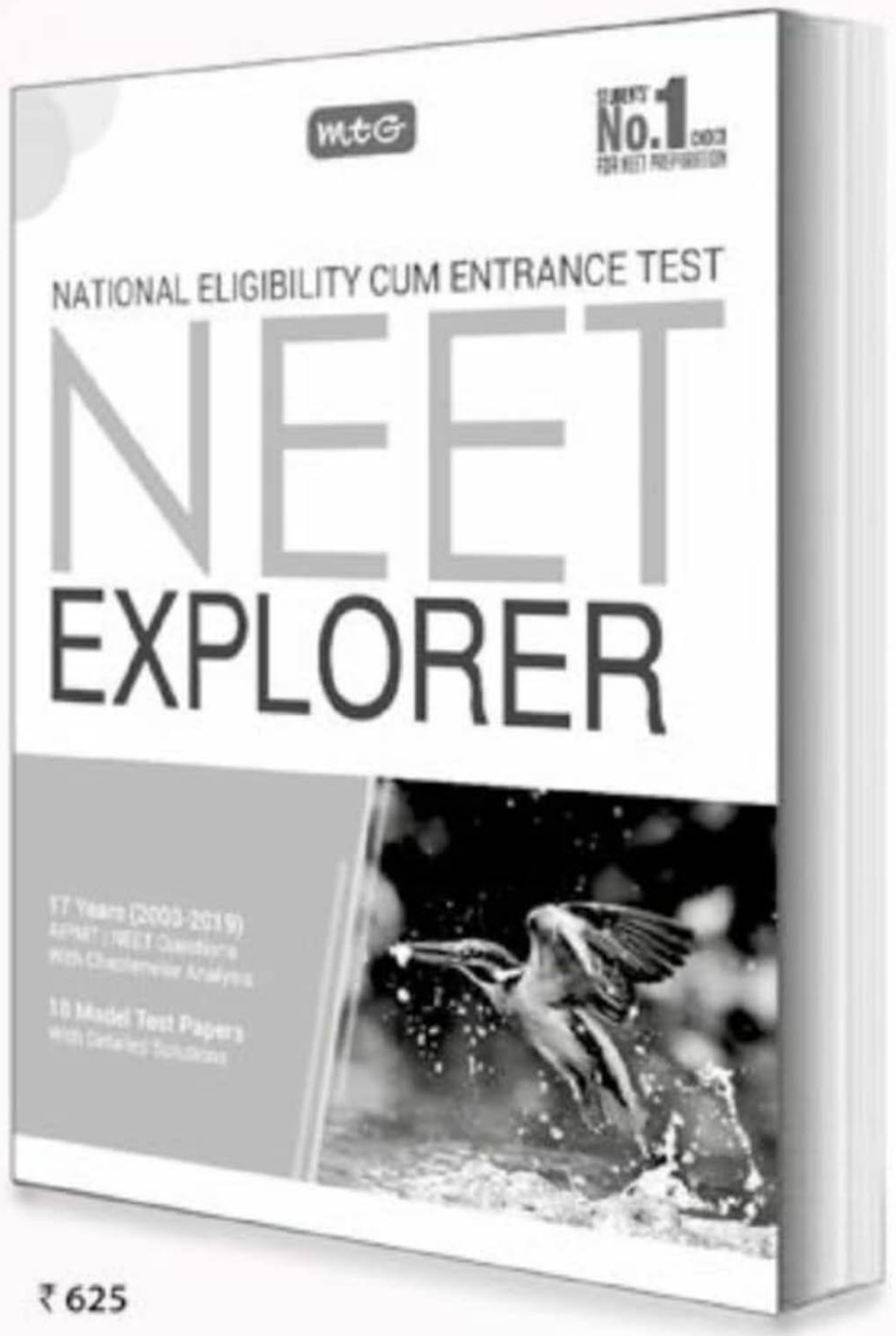
Monthly Test Drive-4 CLASS XI ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(d)	**5.**	(d)
6.	(d)	**7.**	(c)	**8.**	(a)	**9.**	(d)	**10.**	(a)
11.	(c)	**12.**	(b)	**13.**	(a)	**14.**	(c)	**15.**	(a)
16.	(c)	**17.**	(d)	**18.**	(d)	**19.**	(a)	**20.**	(d)
21.	(c)	**22.**	(b)	**23.**	(d)	**24.**	(c)	**25.**	(b)
26.	(d)	**27.**	(d)	**28.**	(b)	**29.**	(b)	**30.**	(c)
31.	(c)	**32.**	(a)	**33.**	(c)	**34.**	(b)	**35.**	(d)
36.	(d)	**37.**	(b)	**38.**	(c)	**39.**	(c)	**40.**	(b)

MTG

Last-minute check on your NEET readiness

STUDENTS' No.1 CHOICE for NEET preparation



₹ 625

MTG's NEET Explorer helps students self-assess their readiness for success in NEET. Attempting the tests put together by MTG's experienced team of editors and experts strictly on the NEET pattern and matching difficulty levels, students can easily measure their preparedness for success.
Order now!

HIGHLIGHTS:

- 10 Model Test Papers based on latest NEET syllabus
- Last 17 years' solved test papers of AIPMT / NEET
- Includes NEET 2019 solved paper
- Detailed solutions for self-assessment and to practice time management

Scan now with your smartphone or tablet*

MTG Learning Media

Available at all leading book shops throughout India.
For more information or for help in placing your order:
Call 0124-6601200 or email: info@mtg.in
*Application to read QR codes required

Visit www.mtg.in for latest offers and to buy online!

(a) Wernicke's area
(b) somato-sensory area
(c) premoter area
(d) Broca's area. *(MH CET 2017)*

17. Which of the following is not the function of cerebellum?
(a) Controlling body posture
(b) Maintaining equilibrium
(c) Controlling rapid muscular activities
(d) Sensory perception

Your favourite MTG Books/Magazines available in GUJARAT at

Abhyas Books - Ahmedabad Ph: 9824288910, 7926766366
Patel Book Agency - Ahmedabad Ph: 079-25324741; 9898184248 , 9824386112
Rohinee Sales - Ahmedabad Ph: 079-27503622, 27508022; 9426758500
Tushar Book Depot Pvt.Ltd. - Ahmedabad Ph: 079-26578741, 26587103, 66613639; 9924526622
Hardik Agency - Ahmedabad Ph: 079-22148725; 9898618613, 7016511436
Mahajan Book Depot - Ahmedabad Ph: 079-25356031; 9824046230
Shalibhadra Stationers - Ahmedabad Ph: 079-25621497; 9904477855
Uppal Brothers - Ahmedabad Ph: 079-22860529; 9426366986
Ajay Book Stall - Anand Ph: 02692-238237; 9925413936
Pothi Prakashan - Anand Ph: 02692-231695; 9409012868, 9924812095
Sai Book Center - Baroda Ph: 8000517344, 9925058175
Priyanshi Books Store & J.D. Agency - Bharuch Ph: 02642-227480; 9099944480, 9427037574
Collegian Book Corner - Dahod Ph: 2673-249981; 9925501981, 9727297624
Paras Book Stall - Jamnagar Ph: 0288-2679597; Mob: 9426453636
Sharda Book Depot - Jamnagar Ph: 0288-2753753, 2751552; 9426946023, 9428941069
College Store - Navsari Ph: 02637-258642; 9825099121
Parimal Book Agency - Rajkot Ph: 0281-2465362, 5522770; 9974740446, 9016297817
Ravi Prakashan - Rajkot Ph: 0281-2460625; 9714036323, 9723364038
Devkrupa Stationers - Rajkot Ph: 0281-2490007; 9824047017, 9033323157
Royal Stationers - Rajkot Ph: 0281-2582926; 9824207514
Shreenathji Prakashan - Rajkot Ph: 9825155314, 9428004605
Shree Gajanan Book Depot - Surat Ph: 0261-6645732; 9879740059
Popular Book Centre - Surat Ph: 0261-2474165; 9825519001, 9327332835
Shopping Point - Surat Ph: 2230097; 9824129592, 9824108663
Shree Gajanan Book House - Surat Ph: 2654921; 9227183775
Surat Books Stall - Surat Ph: 0261-2436911, 2431158; 9825693489
Bansal Book Stall - Vadodara Ph: 2326109; 9898245560
Maneesh Book Shop - Vadodara Ph: 0265-2363270, 2226463; 9898522447
Acharya Book Depot - Vadodara Ph: 0255-2420622; 9824286729, 9409031561
Joshi Brothers Book Sallers - Vadodara Ph: 0265-2410567
Lead Enterprises - Vadodara Ph: 0265-2780168; 9879778853, 9879526853
Shreeji Traders - Vadodara Ph: 9825366479
The Allies Store - Vadodara Ph: 2427887, 6544882; 9537648491
Umakant Book Sellers & Stationers - Vadodara Ph: 0265-2359633, 3059487; 9824014209
Mahavir Sells Corporation - Valsad Ph: 9909570698
Maruti Book Store - Vapi Ph: 0260-2424419; 9428065789, 9428715033
Vinay General Store - Vapi Ph: 9925817463

Visit **"MTG IN YOUR CITY"** on www.mtg.in to locate nearest book seller OR write to **info@mtg.in** OR call **0124-6601200** for further assistance.

18. _______ connects the lateral and third ventricles of brain.
(a) Foramen of Monro
(b) Foramen of Magnum
(c) Aqueduct of Sylvius
(d) Foramina of Luschka

19. Which of the following structures or regions is incorrectly paired with its functions?

(a)	Medulla oblongata	:	Controls respiration and cardiovascular reflexes
(b)	Limbic system	:	Consists of fibre tracts that interconnect different regions of brain and controls movement
(c)	Hypothalamus	:	Production of releasing hormones and regulation of temperature, hunger and thirst
(d)	Corpus callosum	:	Band of fibers connecting left and right cerebral hemispheres

(NEET 2018)

20. Select the correct statements.
(i) Ascending spinal tracts carry sensory impulses to the brain.
(ii) Axons of sensory neurons are located in dorsal root ganglia.
(iii) Descending spinal tracts carry motor impulses from the spinal nerves to the brain.
(iv) Spinal cord is the centre of spinal reflex action.
(a) (i), (ii) and (iii) only
(b) (i) and (ii) only
(c) (i) and (iv) only
(d) (i) only

ANSWER KEY

1.	(c)	**2.**	(d)	**3.**	(c)	**4.**	(a)	**5.**	(b)
6.	(c)	**7.**	(b)	**8.**	(a)	**9.**	(d)	**10.**	(d)
11.	(b)	**12.**	(c)	**13.**	(c)	**14.**	(d)	**15.**	(c)
16.	(d)	**17.**	(d)	**18.**	(a)	**19.**	(b)	**20.**	(c)

☺☺

MEMORY Capsule

*To easily remember twelve cranial nerves the mnemonic "**O**n **O**ld **O**lympus' **T**owering **T**ops, **A** **F**inn **A**nd **G**erman **V**iewed **S**ome **H**ops" can be used as follows:*

O	:	Olfactory	**F**	:	Facial
O	:	Optic	**A**	:	Auditory
O	:	Oculomotor	**G**	:	Glossopharyngeal
T	:	Trochlear	**V**	:	Vagus
T	:	Trigeminal	**S**	:	Sensory
A	:	Abducens	**H**	:	Hypoglossal

CHECK YOUR VITALS

for NEET, AIIMS and JIPMER

Maximise your chance of success in medical entrance exams by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

- Recall question or single concept question – indicated by a single finger.
- Application question or question which requires 2 or 3 concepts - indicated by 2 fingers.
- Application question or question which requires 3 or more concepts - indicated by 3 fingers.

UNIT-IV : PLANT PHYSIOLOGY (PART-II)

CHAPTER-14 : RESPIRATION IN PLANTS

Multiple Choice Questions

1. Which of the following is incorrect regarding the similarities between respiration and combustion?
(a) Both involves breakdown of complex organic substances
(b) Both utilise oxygen
(c) Both include evolution of CO_2 and water
(d) Both liberate most of the energy as heat

2. Identify the correct sequence regarding the respiratory quotient of different substrates.
(a) Carbohydrates > Fats > Proteins > Organic acids
(b) Organic acids > Carbohydrates > Fats > Proteins
(c) Organic acids > Carbohydrates > Proteins > Fats
(d) Carbohydrates > Fats > Organic acids > Proteins

3. Glycolysis involves the breakdown of glucose to pyruvate. This glucose is obtained from the hydrolysis of starch or sucrose with the help of enzymes
(a) amylase or maltase respectively
(b) maltase or amylase respectively
(c) amylase or invertase respectively
(d) invertase or maltase respectively.

4. Which among the following is an irreversible reaction in glycolysis?
(a) Conversion of glucose-6-phosphate to fructose-6-phosphate.
(b) Conversion of glyceraldehyde-3-phosphate to 1 : 3 biphosphoglyceric acid.
(c) Conversion of 3-phosphoglycerate to 2-phosphoglycerate.
(d) Conversion of fructose-1, 6-biphosphate to glyceraldehyde-3-phosphate.

5. Which of the following intermediates of glycolysis is used in the synthesis of raw material for indole acetic acid?
(a) 3-phosphoglycerate
(b) Phosphoenol pyruvate
(c) Dihydroxyacetone-3-phosphate
(d) Glyceraldehyde-3-phosphate

6. Identify the incorrect statement regarding significance of Krebs' cycle.
(a) α-ketoglutarate of Krebs' cycle produces amino acid glutamate.
(b) Succinyl Co-A takes part in synthesis of terpenes and steroids.
(c) In Krebs' cycle GTP is formed which is an important component of signal transduction system.
(d) Krebs' cycle is the major pathway for the synthesis of reduced co-enzymes and controlled release of energy.

7. If the 4 molecules of pyruvic acid will enter into Krebs' cycle, that will lead to
(a) production of 4ATP, 16NADH and $4FADH_2$
(b) production of 4ATP, 8NADH and $4FADH_2$
(c) production of 2ATP, 8NADH and $2FADH_2$
(d) production of 2ATP, 16NADH and $2FADH_2$.

8. Which of the following statement is incorrect regarding the electron transport chain.
(a) Inner mitochondrial membrane contains the group of electron and proton transporting enzymes.
(b) Quinones are highly mobile electron carrier.
(c) The passage of electron from one enzyme to the next is an uphill reaction with the gain of energy at each step.
(d) Complex V is connected with ATP synthesis.

9. Krebs' cycle is a stepwise oxidative and cyclic degradation of acetyl Co-A through
(a) one decarboxylation and two dehydrogenation reactions
(b) two decarboxylation and two dehydrogenation reactions
(c) one decarboxylation and four dehydrogenation reactions
(d) two decarboxylation and four dehydrogenation reactions.

10. Which of the following reaction represents substrate level phosphorylation?
(a) Glucose to glucose-6-phosphate
(b) Glyceraldehyde-3-phosphate to 1,3-biphosphoglycerate
(c) 1,3-biphosphoglycerate to 3-phosphoglycerate
(d) α-ketogluterate to succinyl Co-A.

11. Lactic acid fermentation of pyruvic acid through lactic dehydrogenase enzyme requires the involvement of
(a) NADP and Mn^{+2} (b) ATP and Mn^{+2}
(c) FAD and Zn^{+2} (d) FMN and Zn^{+2}.

12. Consider the given statements and select the correct option.
(i) Floating respiration involves the protein, fats and carbohydrate as the respiratory substances.
(ii) In aerobic respiration, 2870 kJ of energy is liberated per mole of glucose.
(iii) Respiratory quotient in succulent plants is 1 as the volume of CO_2 evolved is equal to volume of O_2 absorbed.
(iv) Oxygen is not required for Krebs' cycle.
(v) The electrochemical potential gradient created across the membrane due to high H^+ concentration on one side is called proton motive force.
(a) (i) and (iii) only (b) (i) and (iv) only
(c) (ii) and (v) only (d) (iii) and (iv) only

13. Cytochrome *b*, FeS complex and cytochrome c_1 are the components of
(a) NADH-UQ reductase complex
(b) Succinate UQ reductase complex
(c) UQH_2 - cytochrome *c* reductase complex
(d) Cytochrome *c* oxidase complex.

14. Conversion of isocitrate to α-ketogluterate in Krebs' cycle involves
(a) formation of intermediate *cis*-aconitase
(b) formation of intermediate oxalosuccinate
(c) formation of intermediate glutarate
(d) formation of intermediate succinate.

15. Which of the following prevents the electron transport between cytochrome *b* and cytochrome c_1?
(a) Cyanide
(b) Antimycin
(c) 2 : 4 dinitrophenol
(d) 2, 4, 5-Trinitrophenol

Match The Columns

16. Match Column I with Column II.

Column I	Column II
A. Aldolase	(i) Glucose-6-phosphate to fructose-6-phosphate
B. Enolase	(ii) 3-phosphoglycerate to 2-phosphoglycerate
C. Phosphohexose isomerase	(iii) 2-Phosphoglycerate to phosphoenol pyruvate
D. Phosphoglyceromutase	(iv) Glyceraldehyde-3-phosphate to 1,3-biphosphoglycerate
E. Glyceraldehyde phosphate dehydrogenase	(v) Fructose-1, 6-biphosphate to glyceraldehyde 3-phosphate

17. Match Column I with Column II. (There can be more than one match for items in column I.)

Column I	Column II
A. Hydration reaction	(i) DHAP $\longrightarrow$ Glyceraldehyde-3-phosphate
B. Oxidation reaction	(ii) 3-phosphoglycerate $\longrightarrow$ 2-phosphoglycerate
C. Phosphorylation	(iii) Succinate $\longrightarrow$ Fumarate
D. Isomerisation	(iv) Fumarate $\longrightarrow$ Malate
	(v) Malate $\longrightarrow$ Oxaloacetate
	(vi) Glucose $\longrightarrow$ Glucose 6-phosphate
	(vii) Pyruvate $\longrightarrow$ Acetyl Co-A

Passage Based Questions

18.(A) Complete the given passage with appropriate words or phrases.

Adenosine triphosphate is formed of a purine, a (i) sugar and a row of three (ii) radicals attached to the sugar. ATP was discovered by (iii). Its functioning through build up and hydrolysis of high energy (iv) was discovered by Fritz Lipmann. Lipmann is called father of (v). In ATP, last two phosphate radicals are attached by bond of (vi). ATP can functions as (vii) of the living cell. ATP is synthesised through an (viii) reaction called (ix), which can be of three types *viz.* (x) phosphorylation, oxidative phosphorylation and photophosphorylation.

(B) Read the given passage and correct the errors, wherever present.

Oxidative photophosphorylation is the consumption of energy rich ATP molecule with the help of electron liberated during oxidation of reduced co-enzymes produced in photosynthesis. The enzyme required for this synthesis is called ATP isomerase. It is considered as the fourth complex of electron transport chain. The enzyme is located in F_0 of F_0 - F_1 particles. The particles are present in the stroma. The enzyme becomes active in ATP formation only where there is electron gradient having higher concentration of electrons on the F_1 side as compared to F_0 side.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false
(d) If both A and R are false.

19. **Assertion :** Protoplasmic respiration cannot be continued for long.
Reason : Protoplasmic respiration depletes structural and functional proteins and also liberates ammonia.

20. **Assertion :** Glycolysis is the common process to both aerobic and anaerobic modes of respiration.
Reason : Pyruvic acid is the common intermediate for both the processes.

21. **Assertion :** Lactic acid fermentation is used in baking industry.
Reason : The product of lactic acid fermentation make the bread spongy.

22. **Assertion :** In anaerobic respiration, only 107 kcal energy are formed per molecule of glucose.
Reason : In an aerobic respiration, inspite of being complete breakdown of respiratory substrate most of the energy is wasted.

23. **Assertion :** The total net gain of ATP is 6 in glycolysis, 6 in acetyl Co-A formation and 22 in Krebs' cycle respectively.
Reason : Each NADH and $FADH_2$ produced during different processes of respiration give rise to 2 and 3 ATP respectively.

24. **Assertion :** ATP functions as energy currency of the living cell.
Reason : It can store small packets of energy as soon as the energy becomes available.

25. **Assertion :** The conversion of α-ketogluterate to succinyl Co-A is an oxidative decarboxylation reaction.
Reason : This reaction involves the activity of aconitase enzyme and release of water.

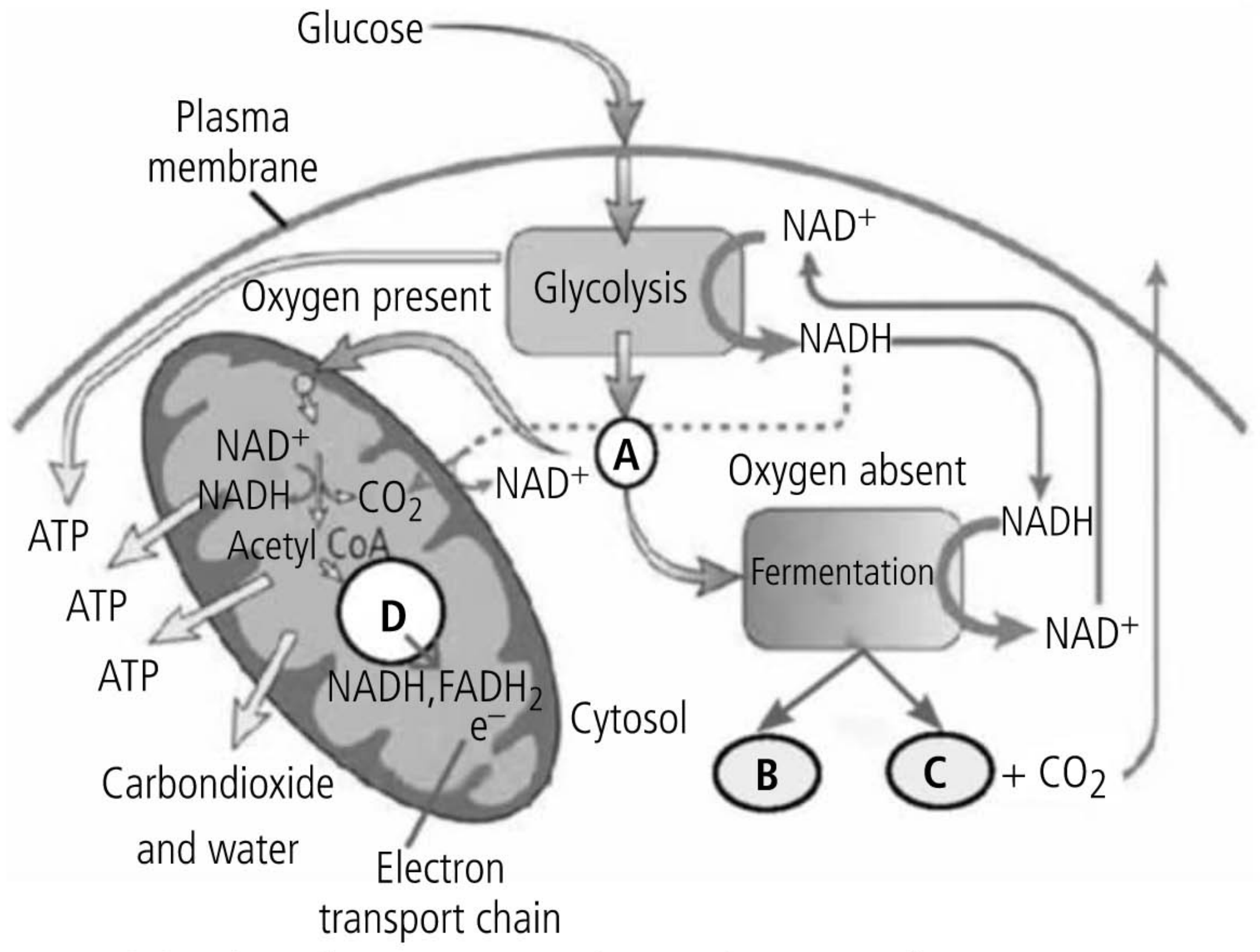
26. **Assertion :** The splitting of fructose-1,6-biphosphate to glyceraldehyde-3-phosphate and dihydroxyacetone-3-phosphate is a reversible reaction.
Reason : Frutose-1,6-biphosphate converts into fructose-6-phosphate when synthesis of ATP is not required.

27. **Assertion :** Anaerobic respiration produces less quantity of CO_2 as compared to aerobic respiration.
Reason : In anaerobic respiration, oxygen is not used in the breakdown of respiratory substrate.

28. **Assertion :** Glycolysis is directly connected with oxidative phosphorylation.
Reason : ATP is produced from the conversion of 1,3-biphosphoglycerate to 3-phosphoglycerate through oxidative phosporylation.

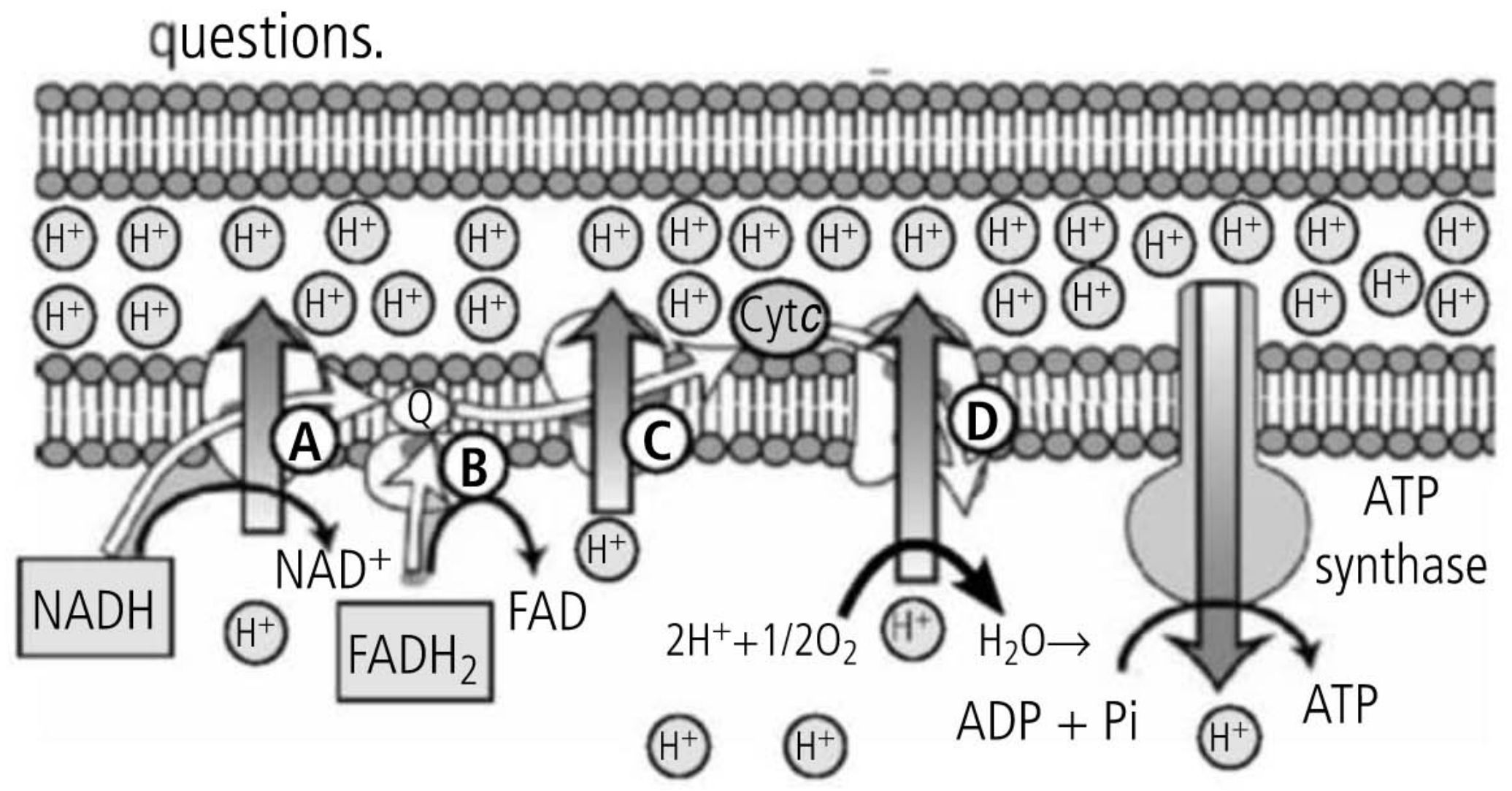
Figure Based Questions

29. Study the given figure and answer the following questions.



(a) Identify, A, B, C and D in the given figure.
(b) What are the benefits of respiratory process by which B and C are produced?
(c) What is the significance of D?

30. Refer to the given figure and answer the following questions.



(a) Identify A, B, C and D in the given figure.
(b) Describe the functioning of this system.
(c) Describe few potent inhibitors of this system.

CHAPTER-15 : PLANT GROWTH AND DEVELOPMENT

Multiple Choice Questions

1. Select the correct statement regarding plant growth regulators.
(a) The response of a PGR is same in different plant organs.
(b) Auxin promotes stem growth and inhibit root growth at same concentration.

(c) Plant growth regulators are effective at very low concentration, usually in the range of 10^{-9}M.
(d) PGR are produced by specialised tissue at the time of requirement.

2. Identify the plant growth regulator that is synthetic but also has natural origin.
(a) Indole-3-acetaldehyde (b) Phenyl acetic acid
(c) Indole-3-acetonitrile (d) Indole-3-butyric acid

3. Which among the following statements is incorrect regarding auxin?
(a) Auxin movement is acropetal in stem and basipetal in roots.
(b) Auxin is synthesised in leaf primordia and developing seeds.
(c) The optimum concentration of auxin required for stem elongation is 10 ppm however for root elongation, it is 0.0001 ppm.
(d) Bound auxins are meant for storage and protection against degradation.

4. Which of the following compounds block the transport of auxin?
(a) Dicamba (b) MCPA
(c) TIBA (d) Both (a) and (c)

5. Flowering in litchi and pineapple can be induced by application of
(a) 2,4-D (b) abscisic acid
(c) gibberellic acid (d) IBA-alanine.

6. In apple, the number of dwarf shoot as well as the number of fruits is enhanced by
(a) naphthalene acetic acid (b) mevalonic acid
(c) kinetin (d) zeatin.

7. Early seed production in conifers can be achieved by
(a) a combination of different auxin hormones
(b) a combination of different gibberellin hormones
(c) a combination of auxin and cytokinin
(d) a combination of cytokinin and gibberellin.

8. A plant supplemented with a hormone/PGR shown the following character.

Female flower, Accumulation of salt inside the cells, Resistance to high and low temperature, Parthenocarpy

Which one could be the possible hormone from the following options?
(a) IBA (b) NAA
(c) Dicamba (d) Zeatin

9. Which of the following hormones is found more abundantly in chloroplast and is formed from xanthophylls?
(a) Dormin (b) Ethylene
(c) Zeatin (d) Indole acetic acid

10. A rose plant was supplemented with a regular dose of coconut milk for a month. What kind of changes might occur in the plant after this activity?
(a) Development of buds
(b) Senescence
(c) More susceptibility to disease
(d) Formation of male flowers

11. Which of the following statements are correct with respect to vernalisation?
(i) Vernalisation brings flowering in temperate flower but not in tropical flowers.
(ii) It decreases yield in henbane but provide resistance to cold and diseases.
(iii) Kernel wrinkles of *Triticale* can be removed by vernalisation.
(iv) Vernalisation requires actively dividing cells and anaerobic respiration.
(v) The stimulus of vernalisation is perceived only by the meristematic cells.
(a) (i) and (ii) only (b) (iii) and (v) only
(c) (iv) and (iii) only (d) (i) and (v) only

12. Generally photoperiodic stimulus is picked up by the fully developed leaves with exceptions _____ in which cotyledons can perceive the stimulus.
(a) *Xanthium strumarium* (b) *Plantago lanceolata*
(c) *Chenopodium rubrum* (d) *Chrysanthemum*

13. Phytochrome, a blue coloured chromoprotein, regulating photoperiodic responses does not involve in
(a) dormancy (b) seed germination
(c) photomorphogenesis (d) mineral nutrition.

14. Which of the following plant growth regulator trigger the ethylene synthesis if present in excess?
(a) Gibberellin (b) Auxin
(c) Zeatin (d) Kinetin

15. Identify the odd pair among the following options, on the basis of their light requirement for flowering.
(a) *Cosmos bipinnatus, Aster*
(b) *Hyoscyamus niger*, Barley
(c) *Bryophyllum*, Larkspur
(d) *Campanula medium*, Petkus variety of Rye

Match The Columns

16. Match Column I with Column II.

	Column I		Column II
A.	Short day plant	(i)	*Cestrum*
B.	Long day plant	(ii)	Cucumber
C.	Day neutral plant	(iii)	*Campanula medium*
D.	Short-long day plant	(iv)	*Spinacea oleracea*
E.	Long-short day plant	(v)	Strawberry

17. Match Column I with Column II. (There can be more than one match for items in column I.)

	Column I		Column II
A.	Cytokinin	(i)	Naphthalene acetamide
B.	Gibberellin	(ii)	Antitranspirant
C.	Auxin	(iii)	Bolting in rosette plants
D.	Abscisic acid	(iv)	6-hydroxy 3-methyl trans 2-butenyl amino-purine
E.	Ethylene	(v)	Chloropenoxy propionic acid
		(vi)	Vernalisation
		(vii)	Positive membrane potential
		(viii)	Barley endosperm bioassay
		(ix)	Excised radish cotyledons expansion bioassay
		(x)	Methionine

Passage Based Questions

18.(A) Complete the given passage with appropriate words or phrases.

Growth, (i) and development processes of plants are found to be regulated by two or more (ii) acting synergistically and antagonistically. Cell division is promoted by both auxin and (iii) synergistically. (iv) is an interplay of auxins and cytokinins, when auxin is in excess, (v) differentiate on the callus while (vi) develops in the presence of excess cytokinin gaseous hormone (vii) have feminising effect on dioecious and monoecious plants whereas (viii) induce the production of male flower in plant. (ix) promotes flowering in some short day plant whereas gibberellins do so in some long day plant.

(B) Read the given passage and correct the errors, wherever present.

Photoperiodic stimulus is picked up by the fully developed flowers. Photoperiodic induction occurs when plant has achieved certain minimum vegetative growth. The minimum number of appropriate photoperiods required for induction varies from one such as *Plantago* to 25 such as *Xanthium*. Florigen perceives stimulus and soon after perceiving the required favourable photoperiod, the leaves produce phytochrome that stabilises in light. It is then passed over to root apex which undergoes differentiation. Photoperiodism has helped plant breeders in effective cross breeding in plants. NBRI has developed the varieties of *Amaranthus* with manipulation of proteins that enables it to flower in different months of year.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false
(d) If both A and R are false.

19. **Assertion :** In *Sonneratia*, the seed is germinated while it is attached to the parent plant.
Reason : Seeds cannot germinate in saline marshes due to the high soil salinity.

20. **Assertion :** Flowering in short day plant can be inhibited by providing red light during dark period.
Reason : Flowering in short day plants can be achieved by providing red light followed by far red light during dark period.

21. **Assertion :** 2,4-D is used to remove broad leaved weeds from cereal crops.
Reason : 2-4-D do not affect mature monocotyledons plants.

22. **Assertion :** Abscisic acid inhibits flowering in short day plants.
Reason : The activity of abscisic acid in influenced by the photoperiodism.

23. **Assertion :** Excess flowers and young fruits are thinned with the help of ethylene.
Reason : Ethylene increases the sensitivity to gravity.

24. **Assertion :** Gibberellins induce flowering in long-day plants under non inductive photoperiods.
Reason : Gibberellin induce flowering in balsam even under non inductive photoperiod.

25. **Assertion :** The treatment of low temperature immediately followed by high temperature induce flowering in henbane.
Reason : The stimulus received by root tips that is translocated to all plant parts through xylem.

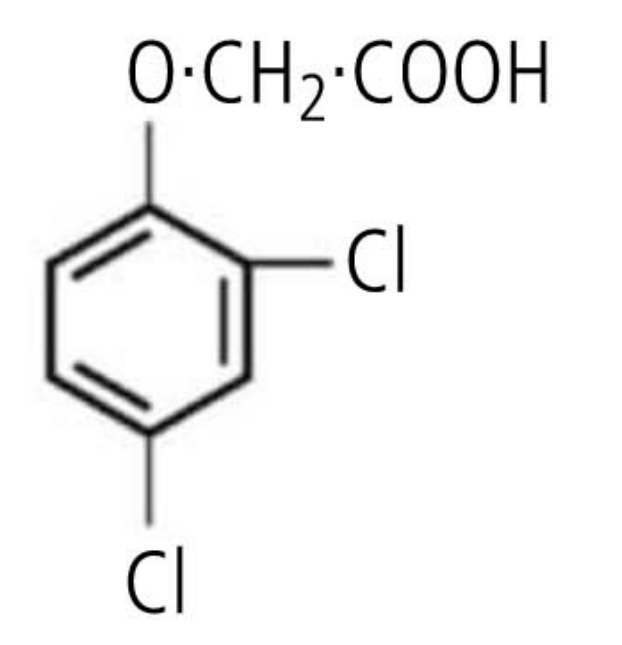
26. **Assertion :** Application of auxins can increase the economic value of tomatoes.
Reason : Auxin application make unpollinated pistils to develop into seedless tomatoes.

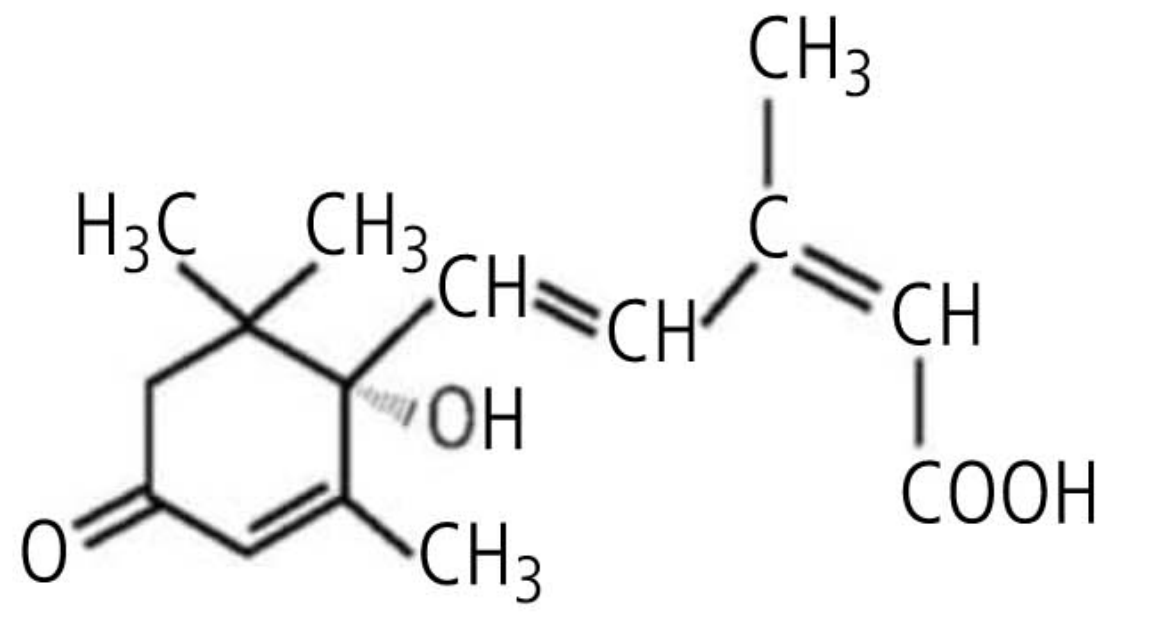
27. **Assertion :** Abscisic acid is known as stress hormone.
Reason : Abscisic acid has an important role in various developmental processes.

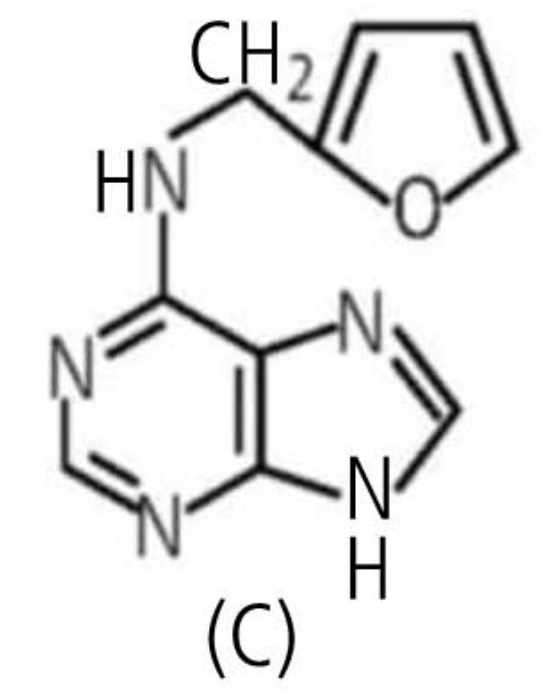
28. **Assertion :** Gibberellin stimulates the seed germination in cereals.
Reason : Gibberellin stimulates the *m*RNA and amylase, lipases and proteases secretions.

Figure Based Questions

29. Refer to the given figures and answer the following questions.


(A)


(B)


(C)

(a) Identify A, B and C in the given figure.
(b) Describe the role of above in plant tissue culture.
(c) Describe the synergistic or antagonistic features of A and B.

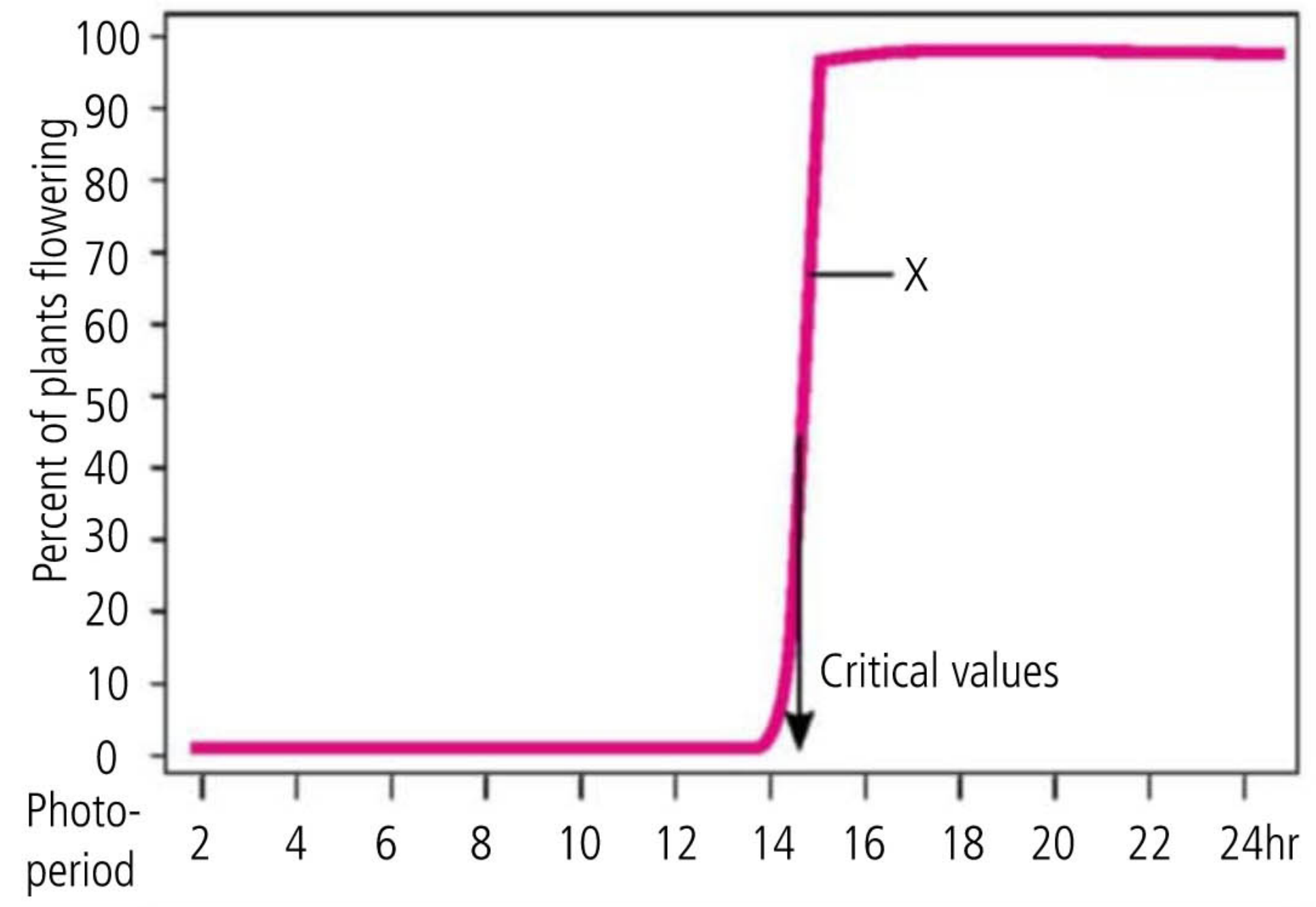
UNSCRAMBLED WORDS

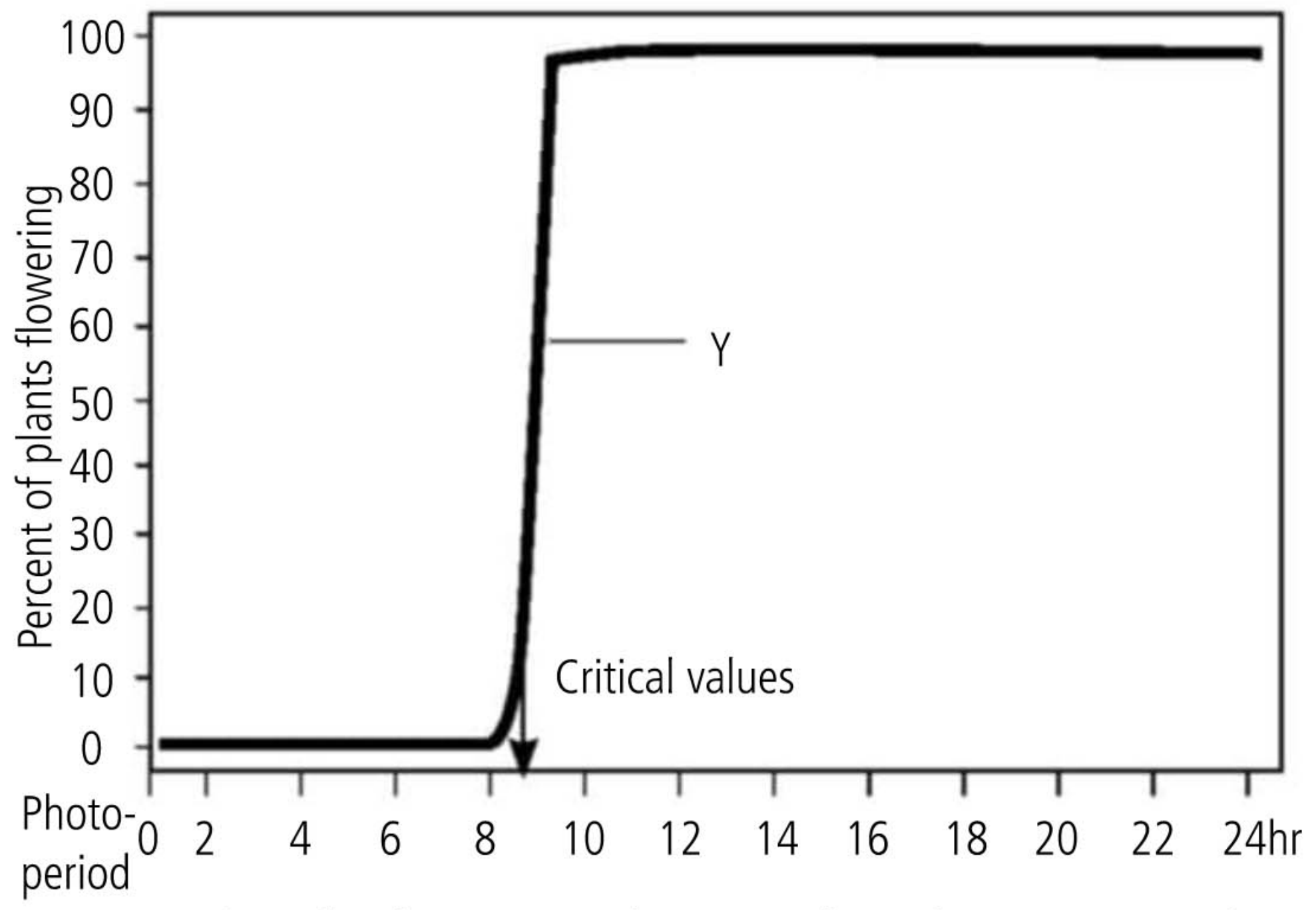
AUGUST 2019

1-h- SPLICING
2-d- GUTTATION
3-e-CHYME
4-a- SCLEREIDS
5-i- BIOLISTIC
6-j- AMENSALISM
7-f- COCHLEA
8-b- AXONEME
9-c- ERYTHROPOIETIN
10-g-COLEORHIZA

Winners : *Abhishek Chakraborty (West Bengal), Debojyoti Sarkar (West Bengal), Ahan Bandyopadhyay (Gwalior)*

30. Study the given graphs and answer the following questions.





(a) Identify plants X and Y regarding the given graph.
(b) What will happen if the Y will be given
(i) Red light in midnight.
(ii) Red light followed by far red light in midnight.
(c) Give few examples of X.

SOLUTIONS

CHAPTER-14 : RESPIRATION IN PLANTS

1. (d) **2.** (c) **3.** (c) **4.** (d) **5.** (b)
6. (b) **7.** (a) **8.** (c) **9.** (d) **10.** (c)
11. (d) **12.** (c) **13.** (c) **14.** (b) **15.** (b)

16. A-(v), B-(iii), C-(i), D-(ii), E-(iv)

17. A-(iv), B-(iii, v, vii), C-(vi), D-(i, ii)

18.(A) (i) ribose (ii) phosphate
(iii) Karl Lohmann (iv) phosphate bond
(v) ATP cycle (vi) high transfer potential
(vii) energy currency (viii) endergonic
(ix) phosphorylation (x) substrate level

(B) Oxidative ~~photophosphorylation~~ phosphorylation is the ~~consumption~~ synthesis of energy rich ATP molecule with the help of ~~electron~~ energy liberated during oxidation of reduced co-enzymes produced in ~~photosynthesis~~ respiration. The enzyme required for this synthesis is called ~~ATP isomerase~~ synthase. It is considered as the ~~fourth~~ fifth complex of electron transport chain. The enzyme is located in ~~F_0~~ F_1 of F_0-F_1 particles. The particles are present in the ~~stroma~~ inner mitochondrial membrane. The enzyme becomes active in ATP formation only where there is ~~electron~~ proton gradient having higher concentration of ~~electrons~~ protons on the ~~F_1~~ F_0 side as compared to ~~F_0~~ F_1 side.

19. (a) **20.** (a) **21.** (d) **22.** (d) **23.** (c)
24. (b) **25.** (c) **26.** (d) **27.** (b) **28.** (d)

29. **(a)** The given figure represents aerobic and anaerobic respiration in living cell. Here A is pyruvic acid, B is lactic acid, C is ethyl alcohol and D is TCA cycle.

(b) The respiration in absence of oxygen is termed as anaerobic respiration. It is exclusive to some parasitic worms, many prokaryotes, several unicellular eukaryotes and moulds. Anaerobic respiration is important during the period of oxygen deficiency. Alcoholic fermentation is used in brewing industry whereas lactic acid fermentation is important for dairy industry. Retting or separation of stem fibers is carried out with the help of bacterial fermentation of softer tissues.

(c) TCA cycle / Krebs' cycle is an important part of aerobic respiration. It is the major pathway for the synthesis of reduced coenzymes and controlled release of energy during respiration. It is a common pathway of oxidative breakdown of carbohydrates, fatty acids and amino acids. α-ketoglutarate of Krebs' cycle produces an important amino acid called glutamate. The intermediate succinyl Co-A takes part in synthesis of pyrrole compounds of chlorophyll, cytochrome and phytochrome.

30. **(a)** In the given figure, A-NADH-UQ reductase complex B-Succinate-UQ-reductase complex, C-UQH_2-cytochrome *c* reductase complex, D-Cytochrome *c* oxidase complex.

(b) The given figure represents electron transport chain. It is a series of coenzymes and cytochromes that take part in the passage of electrons from a chemical to its ultimate acceptor. The passage of electrons from one enzyme or cytochrome to the next is a downhill journey with a loss of energy at each step. At each step the electron carrier includes flavins, iron sulphur complexes, quinones and cytochromes. The last complex is connected with ATP synthesis.

(c) An inhibitor may completely block electron transport by irreversible binding to a binding site. Few potent inhibitors of this system are as follows:
(i) Cyanide - Prevents transfer of electrons from cytochrome a_3 to oxygen.
(ii) Antimycin - Prevents electron transport between cytochrome *b* and cytochrome c_1.
(iii) 2,4-Dinitrophenol - Allow electron transport but prevents ATP synthesis.

CHAPTER-15 : PLANT GROWTH AND DEVELOPMENT

1. (b) **2.** (d) **3.** (a) **4.** (c) **5.** (a)
6. (a) **7.** (b) **8.** (d) **9.** (a) **10.** (a)
11. (b) **12.** (c) **13.** (d) **14.** (b) **15.** (c)

16. A-(v), B-(iv), C-(ii), D-(iii), E-(i)

17. A-(iv, ix), B-(iii, vi, viii), C-(i, v), D-(ii, vii), E-(x)

18.(A) (i) differentiation (ii) Phytohormones
(iii) cytokinin (iv) morphogenesis
(v) roots (vi) bud
(vii) ethylene (viii) Gibberellin
(ix) Abscisic acid

(B) Photoperiodic stimulus is picked up by the fully developed ~~flowers~~ leaves. Photoperiodic induction occurs when plant has achieved certain minimum vegetative growth. The minimum number of appropriate photoperiods required for induction varies from one such as ~~*Plantago*~~ *Xanthium* to 25 such as ~~*Xanthium*~~ *Plantago*. ~~Florigen~~ Phytochrome perceives stimulus and soon after perceiving the required favourable photoperiod, the leaves produce ~~phytochrome~~ florigen that stabilises in ~~light~~ dark. It is then passed over to ~~root~~ shoot apex which undergoes differentiation. Photoperiodism has helped plant breeders in effective cross breeding in plants. NBRI has developed the varieties of ~~*Amaranthus*~~ *Chrysanthemum* with manipulation of ~~proteins~~ genes that enables it to flower in different months of year.

19. (a) **20.** (b) **21.** (a) **22.** (d) **23.** (c)
24. (b) **25.** (d) **26.** (a) **27.** (b) **28.** (a)

29. **(a)** A- 2,4-D (Auxin), B- Abscisic acid, C- Kinetin (Cytokinin).

(b) Growth regulators plays an important role in plant tissue culture the most commonly used PGR in tissue culture are auxins and cytokinins.
Auxin facilitates cell division and root differentiation. These induce cell division, cell elongation and callus formation in cultures. Cytokinin also induce cell division and differentiation. These promote RNA synthesis and stimulate proteins and enzyme activities in tissues. High auxin to cytokinin ratio promotes rooting in cultures whereas high cytokinin to auxin ratio promotes shoot induction in cultures. Abscisic acid is used in plant tissue culture to promote distinct developmental pathways such as somatic embryogenesis.

(c) The synergistic features of A and B are as follows : Auxin delays abscission of young leaves and fruits however abscisic acid is responsible for abscission in plants. Auxin promotes growth by promoting cell division, whereas abscisic acid counteracts its effect and keep its activity under check. Auxin produce negative potential in the cell membrane while abscisic acid produce positive potential in cell membrane. Auxin increase cambial activity whereas abscisic acid stops mitosis in vascular cambium. The synergistic effects of auxin and abscisic acid are as follows: Both promote flowering, rooting in stem cutting and parthenocarpy. Flowering and parthenocarpy is not usual function of abscisic acid but it is reported in few plant species.

30. **(a)** The given graph represents the photoperiod required for plants. Here X is long day plant and Y is short day plant.

(b) Y represents the short day plants and SDP flower when the photoperiod or day length is below a critical period. In condition (i) the short day plant will not flower because the continuous critical dark period is interrupted with red light this phenomenon is called light break reaction. In condition (ii) the flowering will occur as the effect of red light can, however, be prevented by immediately providing far red light.

(c) Example of long day plants are *Hyoscyamus niger*, wheat, oat, sugar beet, *Spinacea oleracea*, radish, barley larkspur and lettuce, etc.

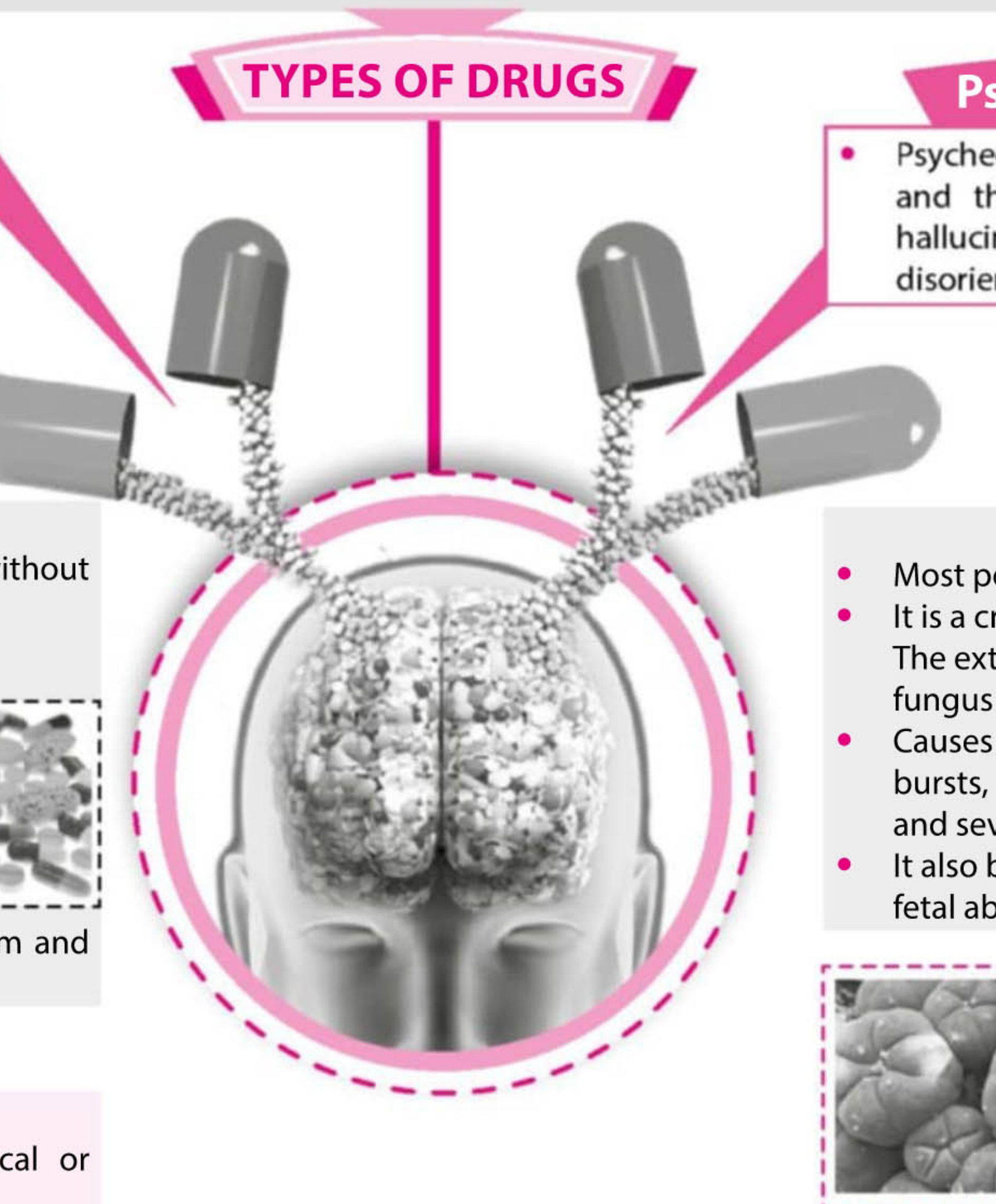
☺☺

CONCEPT MAP

DRUG ABUSE

Drug is the active chemical substance used in the treatment, cure, prevention, or diagnosis of diseases or used to otherwise enhance the physical or mental well-being. When drug is taken into the body, it alters the body's function either physically and / or physiologically. Drugs are normally used as medicines to help patients cope with physical and mental illness. But when drugs are taken for a purpose other than normal clinical use, it can cause the impairment of one's physical, physiological and psychological functions, it is called **drug abuse**. Drug abuse is the alarming trend among youths which can cause dangerous impact on healthy life style. The habituating drugs can be classified into two categories : psychotropic drugs and psychedelic drugs.

TYPES OF DRUGS

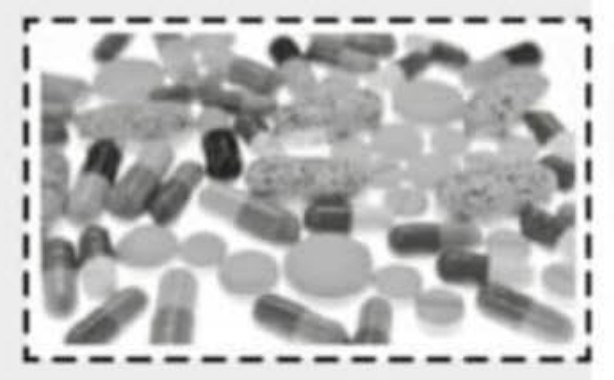


Psychotropic drugs

- Psychotropic drugs are mood alternating drugs which affect the functioning of the mind through pharmacological action on the central nervous system.

Tranquillisers

- Decrease tension and anxiety and produce a feeling of calmness without sedating and inducing sleep.
- These are of two types : phenothiazines and benzodiazepines.
- **Phenothiazines** are antipsychotic drugs which have good effect in all types of psychosis, specially schizophrenia. *E.g.*, chlorpromazine and reserpine, etc.
- **Benzodiazepines** are used for anxiety and phobic conditions. They produce skeletal muscle relaxation without disturbing voluntary activity. *e.g.*, Diazepam and Flurazepam, etc.



Sedatives and hypnotics

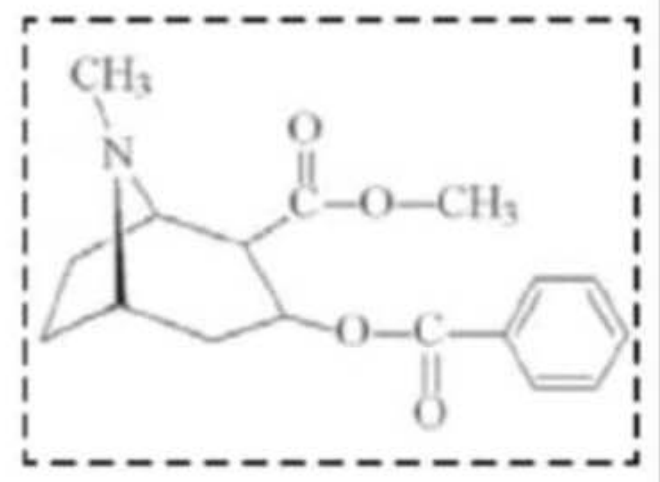
- Reduces excitement, relieves pain and lowers the physiological or functional activity leading to drowsiness or sleep.
- **Hypnotic** is also a drug that induces sleep.
- Generally they are CNS depressants. *E.g.*, barbiturates and benzodiazepines.
- **Barbiturates** are synthetic drugs which are derivatives of barbituric acid. Barbiturates are **general depressants** for all excitable cells but the CNS is most sensitive to these drugs and are taken to reduce anxiety and induce sleep. They are popularly called **sleeping pills**. Benzodiazepines (BZDs) are antianxiety as well as sedative drugs.

Stimulants

- Stimulate the nervous system; make a person more wakeful, active; and cause excitement.
- It temporarily increases alertness and energy.

Natural stimulants

- **Caffeine** (1, 3, 7 Trimethylxanthine) is a CNS stimulant, obtained from seeds of *Coffea arabica* and leaves of *Thea sinensis*. It provides a sense of wellbeing, alertness, beats boredom, thinking becomes clear, improves performance.
- **Cocaine** is bitter, white, crystalline powder obtained from *Erythroxylum coca*. It is a strong CNS stimulant.



- It induces a sense of wellbeing, pleasure, delays fatigue, increases heart beat, blood pressure and body temperature. Also causes lack of sleep and loss of appetite.
- **Crack** is a derivative of cocaine. It is relatively cheap but extremely addictive, can cause heart and mental problems.
- **Betelnut** is a mild CNS stimulant. It stains teeth and gum red.

Synthetic stimulants

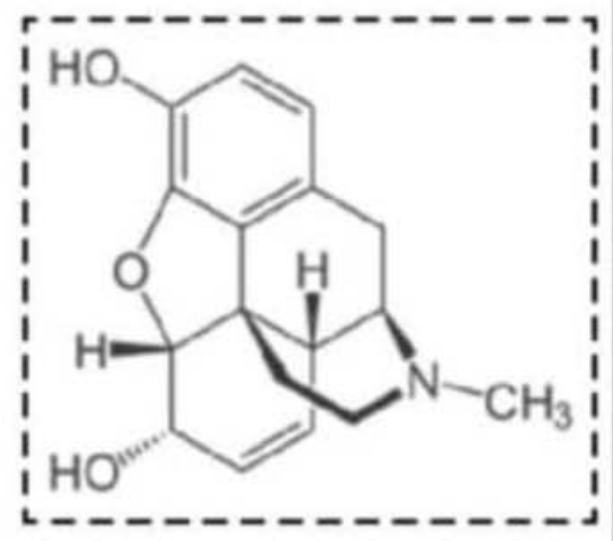
- **Amphetamines** commonly called pep pills, anti sleep drugs or supermen as they are CNS stimulants. They cause alertness, self-confidence, talkativeness and increased work capacity and stimulate respiratory centre. Suppress hunger (anorexia) and cause addiction.

Opiate narcotics

- Opium drugs are obtained from poppy plant (*Papaver somniferum*).
- Relieves pain by acting on the CNS.
- Analgesic, also called pain killers.
- Opiates block pain signals between the brain and body.
- Opiates have narcotic, astringent and sedative effects. It slows down respiratory activity, cause constriction of pupil of eye, decrease glandular secretions, impair the digestion, produce nausea, vomiting and sterility.

Natural opiates

- **Morphine** is a strong analgesic, has sedative and calming effect. Morphine depresses respiratory centre, lowers the BP, causes bradycardia (slow heart beat). Constipation is a prominent feature of morphine action.
- **Codeine** is also a derivative of opium, it is methyl-morphine which occurs naturally in opium and is partly converted in the body to morphine.
- It is mild analgesic and does not causes addiction.



Semisynthetic opiates

- **Heroin** is 3 times more potent than morphine and is highly addictive. It is considered as most dangerous opiate.
- Heroin is a depressant and slows down body functions.
- Induces drowsiness and lethargy.
- **Smack** is a crude by-product of heroin synthesis and is commonly called **"brown sugar"**. It is stronger analgesic than morphine.

Synthetic opiates

- **Pethidine** has similar action to morphine. Its analgesic efficiency is near to morphine and is more than codeine. Causes less histamine release and is safer in asthmatics. It also has local anaesthetic action.
- **Methadone** is slightly stronger and longer than that of morphine. It has analgesic, respiratory depressant, constipating actions similar to morphine.

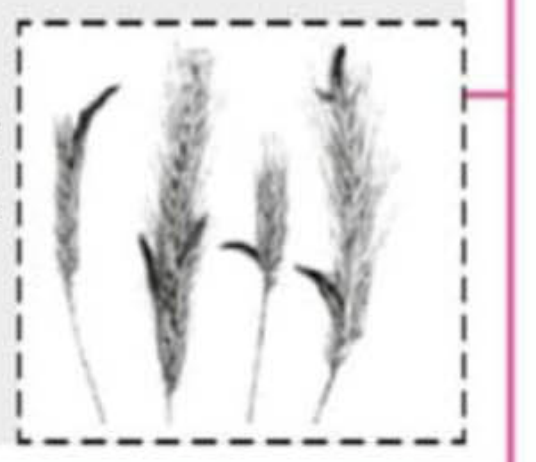
Psychedelic drugs (Hallucinogens)

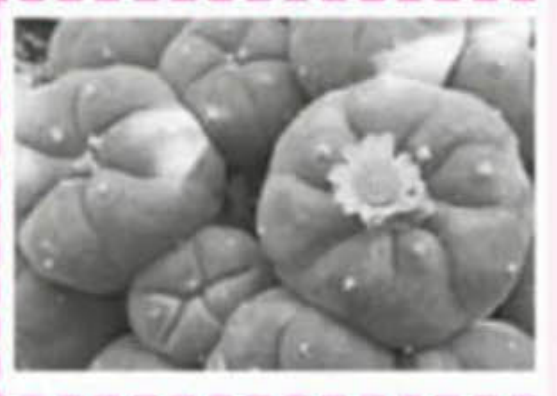
- Psychedelic drugs induce state of altered perception and thought without any actual sensory stimulus. The hallucinogens, in general produce a dream-like state with the disorientation and loss of contact with reality.

Natural hallucinogens

LSD (Lysergic acid diethylamide)

- Most powerful psychedelic.
- It is a crystalline amidated alkaloid obtained from **ergot**. The extract got from fruiting body of fungus *Claviceps purpurea*.
- Causes horrible dreams, emotional out bursts, hallucination, chronic psychosis and severe damage to CNS.
- It also brings about chromosomal and fetal abnormalities.





Mescaline

- It is a white powdery alkaloid, obtained from the tops of a small spineless cactus, *Lophophora williamsii*.
- It is a low potency hallucinogen.

Psilocybine

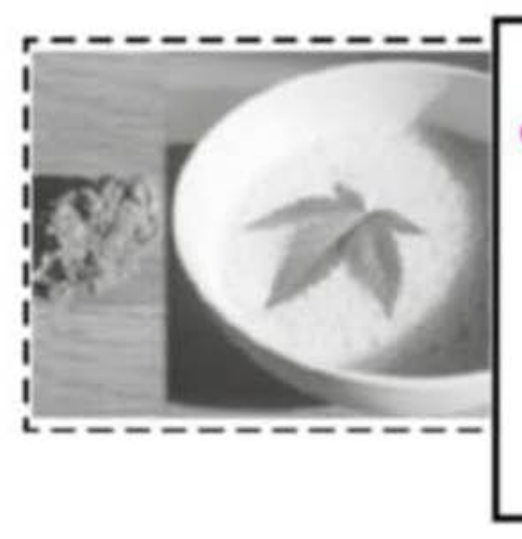
- It is a crystalline solid, obtained from the fruiting bodies of Mexican mushroom (fungus) *Psilocybe mexicana*.
- Effects are similar to mescaline.

Datura and Belladona

- Seeds of *Datura stramonium* and aerial parts of *Atropa belladona* are misused for their hallucinogenic properties. Even in slight excess, they can cause death.

Cannabinoids

- Obtained from hemp plant, *Cannabis sativa.*
- Interact with cannabinoid receptors present mainly in the brain.



Bhang

- It is fresh/dried leaves and flowering shoots of both male and female plants of *Cannabis sativa*. Bhang is generally taken orally in form of drink or pakora or tikki. It acts slowly.

Ganja

- Dried unfertilised female inflorescence of *Cannabis sativa*. It is smoked generally in cigarettes. Its effects are produced almost instantaneously.

Charas

- It is dried resinous extract from flowering tops and leaves of *Cannabis sativa*. It is most potent and smoked with tobacco. It gives temporary feeling of well being and happiness.

Marijuana

- It is obtained from the dried flowers and top leaves of the female plants of *Cannabis sativa*.
- Most active ingredient of marijuana is delta - 9 tetrahydrocannabinol (Delta - 9 THC). It is smoked in cigarettes. It may cause psychosis.

Synthetic hallucinogens

PCP (Phencyclidine Piperidine)

- Stimulant, depressant, hallucinogenic and analgesic.
- Also known as "**angel dust**".

Methylenedioxymethamphetamine (MDMA)

- CNS - excitant and hallucinogenic.
- Increases communication.
- Popular by name of "**Ecstasy drug**".

Class XII

BIO Digest

This article covers high yield facts of the given topic.

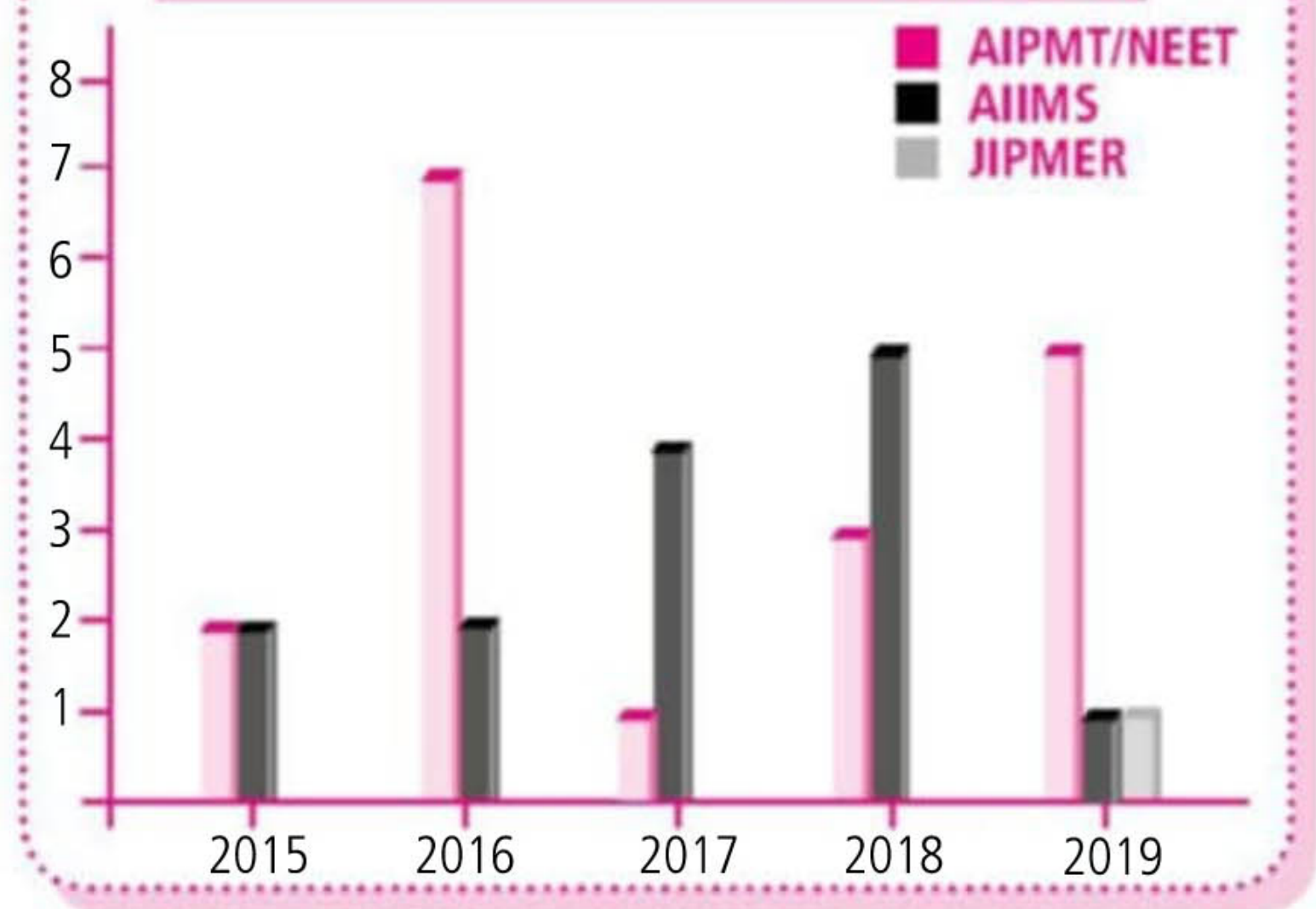
Evolution

- **Evolution** is the orderly heritable changes in populations over successive generations.
- **Evolutionary biology** is the study of history of life forms on earth.
- Universe or cosmos is the whole existing space and matter that is differentiated into several galaxies with each galaxy having several stars and clouds of gas and dust. The study of universe is known as **cosmology**.
- Most accepted theory to explain the origin of universe is the **Big-Bang Theory**, proposed by **Abbe Lemaitre** (1931) which states that the universe had an explosive beginning. Universe originated about 20 billion years ago by a thermonuclear explosion or big bang.

ORIGIN OF LIFE

- Life is an inherent capacity possessed by an organism to maintain and reproduce itself. The origin of life is considered as an unique event in the history of universe.
- Life appeared 500 million years after the formation of earth.
- To explain the origin of life, many theories were put forward.
- **Theory of spontaneous generation** or **autogenesis** or **abiogenesis** believe that under certain conditions non-living substances gave rise to living beings spontaneously. This concept was supported by **Thales, Anaximander, Aristotle, Plato**, etc.
- **Theory of Panspermia** was proposed by **Richter** in 1865, according to which life came from outside in the form of spores.
- **Oparin-Haldane theory of origin of life** was put forward by **A.I. Oparin**, a Russian biochemist and **J.B.S. Haldane**, an English biologist. According to this theory, life originated on earth spontaneously from non-living matter, first inorganic compounds and then organic compounds were formed in accordance with ever changing environmental conditions.
- Oparin-Haldane theory is also called chemical theory or naturalistic theory.

Analysis of various PMTs from 2015-2019



- Haldane gave the term **hot dilute soup** or **prebiotic soup** for broth of chemicals formed in oceans of the early earth from which living cells are believed to have appeared.

- The Oparin-Haldane theory was experimentally supported by **Stanley Miller** (1953) a student of Harold Urey. In **Stanley Miller's experiment**, electric discharge was created in a closed flask containing mixture of four gases- CH_4, H_2, NH_3 and water vapour at 800°C temperature. The mixture was passed through a condenser and gases were circulated for about one week resulting in the formation of amino acids, such as alanine, glycine and aspartic acid.
- The synthesis of carbohydrates, fats, amino acids and other complex organic molecules from simple organic molecules probably occurred in sea in primeval atmosphere. Electric discharge, ATP, solar energy, lightning might have provided the source of energy.
- **Biological evolution** is defined as the process through which the characteristics of organisms change over successive generation by means of genetic variation and natural selection.
- Oparin gave the term **coacervates** for non-living structures, from which first living cells were formed. Coacervates are surrounded by a thin film of water, lack a definite membrane but are able to grow and divide in a favourable environment.
- Proteinoids are protein like structures formed by dehydration synthesis of amino acid. **Sydney Fox** demonstrated that **microspheres** could be formed from proteinoids placed in boiling water.
- The first living organism which originated from organic molecules in oxygen free atmosphere (reducing atmosphere) were **anaerobes**. They were capable of anaerobic respiration and lived in the absence of oxygen. They depended on the existing organic molecules for their nutrition and thus they were **heterotrophs**.
- Some of these **prokaryotic heterotrophs** might have evolved into autotrophs when the supply of existing organic molecules was exhausted.
- The **eukaryotes** developed from primitive prokaryotic cells about 1.5 billion years ago. There are two theories regarding origin of eukaryotes.
- According to **symbiotic theory**, some anaerobic predator host cells engulfed primitive aerobic bacteria but did not digest them. These aerobic bacteria became symbionts. Such predator host cells evolved into first prokaryotic cells.
- According to **origin by invagination theory**, cell organelles of eukaryotic cells might have originated by invagination of surface membrane of primitive prokaryotic cells.
- Primitive eukaryotes led to the evolution of protists, plants, fungi and animals. Life was present on earth about 3.9 billion years ago.

EVIDENCES OF EVOLUTION

- Evolution is gradual change in the characteristics of a species over several generations and relies on the process of natural selection.
- **Homologous organs** have the same fundamental structures but are different in functions. Thus, homology between organs of different animals is based on common ancestry or common embryonic origin and built on the same fundamental pattern but in adult conditions, they get modified to perform different functions. *E.g.*, the forelimbs of a man, cheetah, whale and bat perform different functions but exhibit same structural plan of bones.

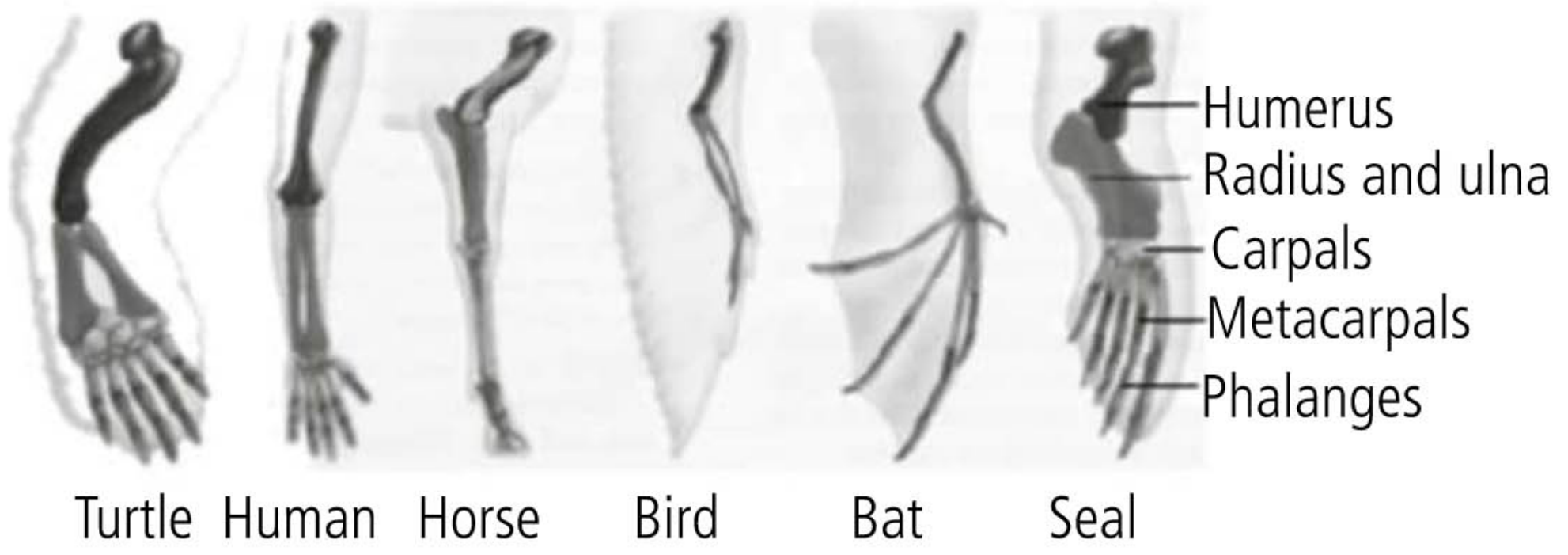


Fig.: Examples of homologous organs in animals

- The homologous structures are a result of **divergent evolution**. Homology indicates common ancestry.
- Development of different functional structures from common ancestral form is called **adaptive radiation**. It can also be defined as, the process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography.
- **Analogous organs** have similar functions but are different in their structural details and origin. *E.g.*, wings of a butterfly, bird and bat serve the same function but their basic structures are totally different.

WHO AM I ...

"I am the movement of alleles among populations by the migration of breeding individuals."

...search me ☺

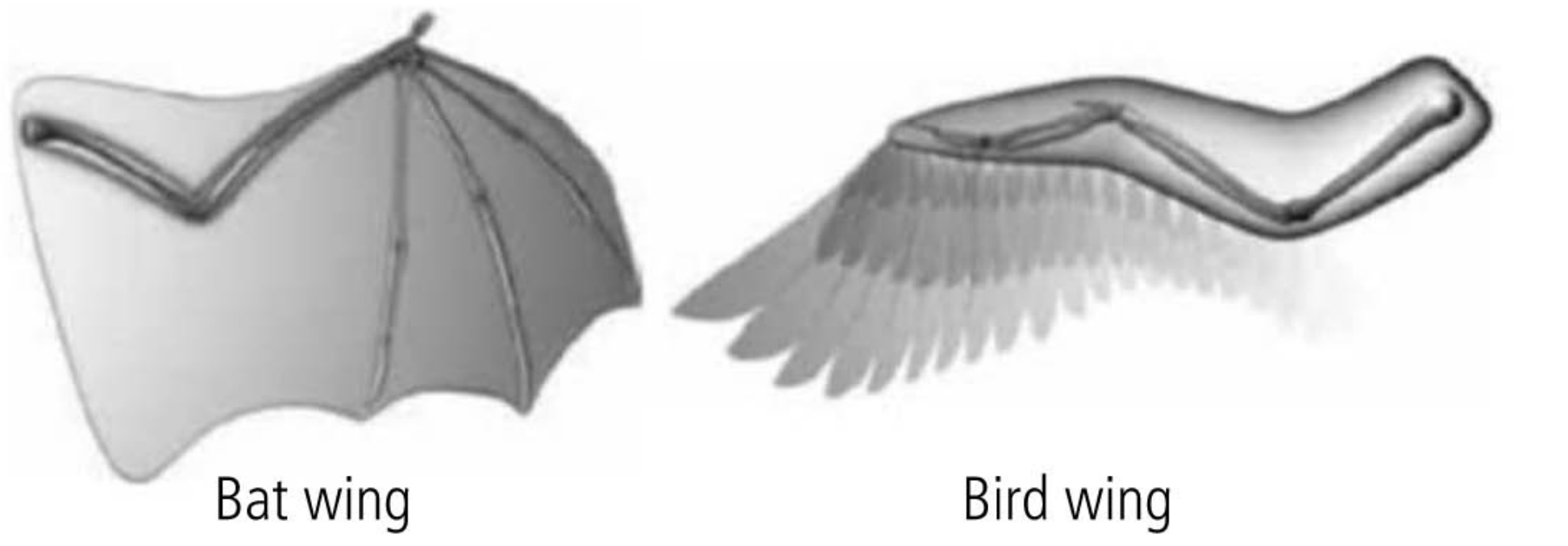


Fig.: Wings of bat are analogous to wings of birds

- The analogous structures are a result of **convergent evolution**.
- Homology in the embryos of closely related vertebrates, indicates their **evolutionary relationship**.
- **Recapitulation theory** or **Biogenetic Law** is based on this evolutionary relationship which states that "**Ontogeny repeats phylogeny**". This means an organism repeats its ancestral history during its development. *E.g.*, in development of frog a fish-like tailed larva (tadpole) is formed, which swims and respires by gills. It indicates that the frog has evolved from a fish-like ancestor.
- **Vestigial organs** are organs present in reduced form and are non-functional. *E.g.*, nictitating membrane, vermiform appendix, hair on body, etc.
- Some organisms possess characters of two different groups of organisms, hence are called **connecting links**. Some examples of connecting links are as follows:

Connecting links	Group of organisms
Euglena	Between plants and animals
Peripatus	Between annelida and arthropoda
Balanoglossus	Between non-chordates and chordates
Chimaera	Between cartilaginous fishes and bony fishes

- **Atavism**, the reappearance of certain ancestral characters which either disappeared or reduced, is another important evidence of evolution. *E.g.*, short tail in some human babies, winged petiole in *Citrus*, etc.
- Different aspects of biochemical affinity like, metabolic processes, enzymes, hormones, blood, lymph and blood proteins are the most convincing evidences of common ancestry.
- Direct evidence of organic evolution comes from the fossil study. **Fossils** are the petrified remains or impressions of organisms that lived in past and got preserved in the sedimentary rocks.
- The study of past life forms based on fossil records is known as **palaeontology**.
- The age of fossils is determined by **radioactive dating technique**. Fossil record can be arranged in chronological sequence once their age is determined.
- **Geological time scale** is prepared in chronological order based on fossil studies to illustrate the history of evolution.
- Fossil evidences which show combined features of two groups are called **missing links**. *E.g.*, *Archaeopteryx* displays the characters of both reptiles and birds.

THEORIES OF EVOLUTION

- Various theories have been put forward to understand and explain the process of evolution by many scientists such as **Lamarck, Darwin, de Vries**, etc.
- The first theory of evolution was proposed by **Jean Baptiste de Lamarck** in 1809 and was published in '*Philosophie Zoologique*'. It is popularly known as **Lamarckism**.
- According to Lamarckism:
  - **Doctrine of desire** - Changing environment gives rise to new needs in an individual.
  - **Use and disuse of organs -** Continuous use of an organ leads to its development and disuse results in degeneration.
  - **Inheritance of acquired characters** means structural and functional changes acquired during the lifetime of an individual are inherited by its offspring and by accumulation of acquired characters new species originates. *E.g.*, disappearance of limbs in snakes, evolution of flightless birds from their flying ancestors, etc.
- **Theory of continuity of germplasm**- Experiments conducted by **A. Weismann** discarded the law of inheritance of acquired characters. It proved that only those characters affecting germ cells are inherited. It proved the continuity of germplasm and not the somatoplasm to the next generation.
- According to **Neo-Lamarckism**, a modified form of Lamarckism, the acquired characters which become incorporated in the germplasm are heritable and accumulation through generation after generation results in the origin of new species.
- The '**Theory of Natural Selection**' was put forward by **Charles Darwin** in 1858.
- The main features of the theory of natural selection are:
  - **Over production :** All organisms possess enormous fertility and multiply in geometric ratio.
  - **Limited food and space :** Food and space remain almost constant, so, they affect the survival of an individual.
  - **Struggle for existence :** Limited supply of food and space causes struggle for existence either between individuals of same species or different species.
  - **Appearance of variations :** Continuous struggle for existence compels organisms to change according to

conditions in order to survive successfully. This produces variations among individuals.

- **Natural selection :** Organisms with favourable variations survive and are better adjusted to the changing environment. Originally it was an idea of **Herbert Spencer** who termed it as '**Survival of the Fittest**'. **Darwin** named it as Natural Selection. Organisms capable of adapting to the changing environmental conditions have better rate of survival.
- **Inheritance of useful variations :** Only useful variations acquired by organism are transmitted to next generation, while non-useful variations get eliminated.
- **Formation of new species :** Useful variations keep on accumulating and are transmitted to generation after generation and new species is formed.

- **Mutation Theory** was proposed by **Hugo de Vries** in 1901. According to this theory new species originates due to discontinuous variations or mutations which appear suddenly. Mutations are subjected to natural selection where mutants found unsuitable are destroyed.

INTEXT PRACTICE QUESTIONS

1. **Name two cell organelles supporting symbiotic theory.**
2. **What is recapitulation theory?**
3. **What do you mean by 'doctrine of desire'?**

Synthetic Theory of Evolution

- Modern concept of evolution is the synthesis of Darwin's and Hugo de Vries theories. It is the result of the work of a number of scientists namely **T. Dobzhansky, R.A. Fisher, J.B.S. Haldane, Sewall Wright, Ernst Mayr** and **G.L. Stebbins**.
- According to **synthetic theory** there are five basic factors involved in the process of organic evolution.

I. **Genetic variations :** Evolution of species occurs through the accumulation of genetic variations in the gene pool of population over long period of time. Variations occur in many ways –

(i) **Mutations :** Gene mutation is the permanent random alteration of the nucleotide sequence of a gene. **Gene pool** is the sum total of all the different genes and their alleles present in a population. Variations occur in gene pool due to the change of gene frequency by mutation.

(ii) **Gene recombination :** It occurs due to the dual parentage, independent assortment of chromosomes, crossing over during meiosis, random fusion of gametes and formation of new alleles.

(iii) **Gene migration (gene flow) :** It is the movement of alleles among populations by the migration of breeding individuals. A constant gene flow can occur between adjacent animal populations due to the migration of organisms.

(iv) **Genetic drift :** It is the drastic change in allele frequency when the population size becomes very small. It was proposed by **Sewall Wright** in 1930 and hence, also called **Sewall Wright Effect**. It occurs when a section of population migrates or dies of natural calamity and thus the gene frequency of the remaining population gets altered. Two important examples of genetic drift are founder effect and bottleneck effect.

- **Founder effect :** When a few individuals or a small group of individuals called **founders** move from some large population and invade a new geographical region, the population in new settlement may have different genotype frequency than that of parent population. The descendants of the founder isolate in new area and tend to have allele ratio similar to the founders rather than to the source population.
- **Bottleneck effect :** The yearly or seasonal cycle phenomenon of decrease or increase in size of a population causing periodic squeezing of some of the genes in gene pool is called bottleneck phenomenon.

(v) **Hybridisation :** It is the crossing of organisms which are genetically different in one or more characters. It helps in intermingling of genes of different groups of the same variety, species and sometimes of different species.

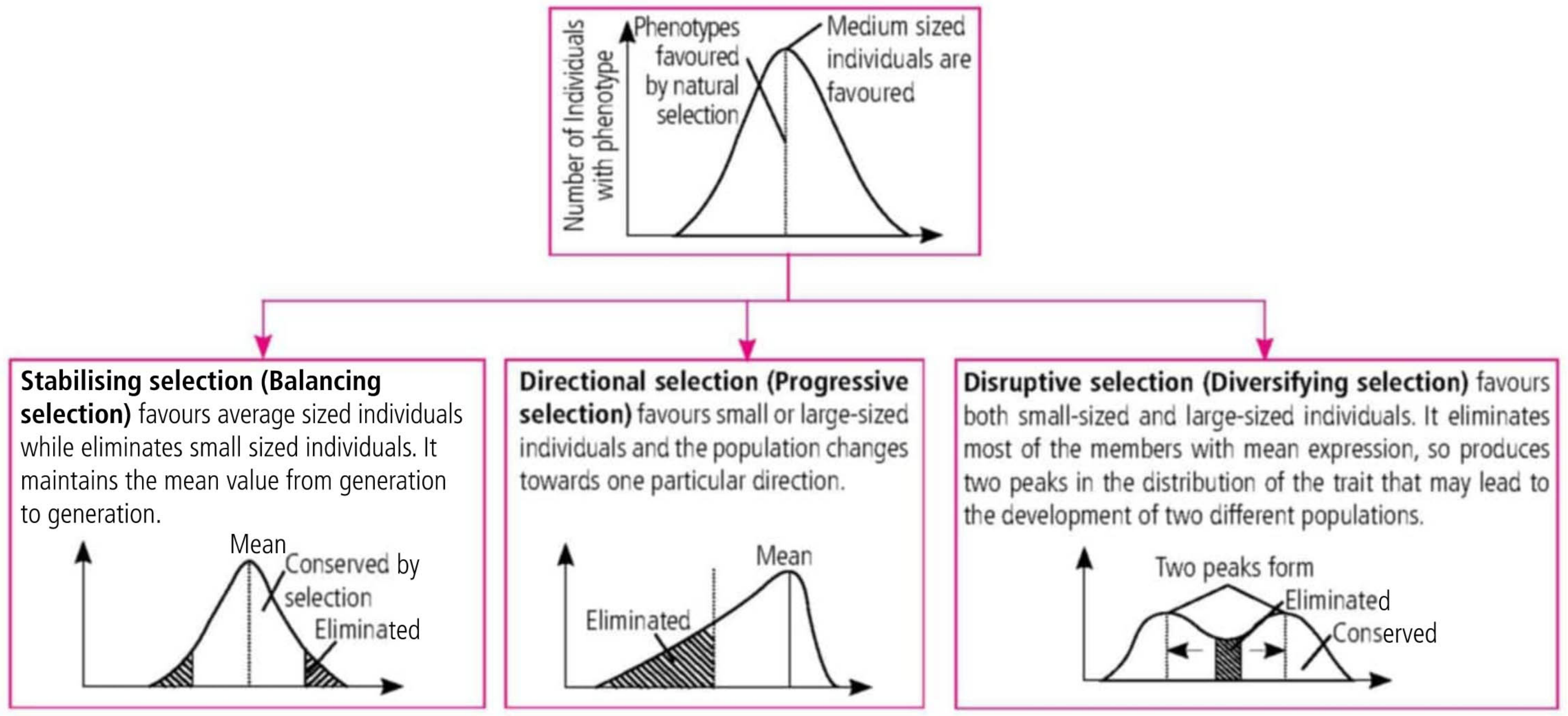
II. **Inheritance of Variations :** Transmission of variations or characteristics from parent to offspring is an important mechanism in evolution and is called **heredity**.

WHO AM I ...
"I am a type of natural selection and I favour individuals at both extremes, and mostly eliminate members with mean expression."
...search me ☺

- Organisms possessing hereditary characters that are helpful in the changing environment, are favoured in the struggle for existence.

III. **Natural Selection :** It results from differential reproduction which means some members of population have traits that enable them to grow up and reproduce at a higher rate and leave more surviving offspring in the next generation than others. They are selected by nature.

- The different types of natural selections based upon different organism-environment relationship are discussed as follows:


Number of Individuals with phenotype
Phenotypes favoured by natural selection
Medium sized individuals are favoured
Mean
Conserved by selection
Eliminated
Eliminated
Mean
Two peaks form
Eliminated
Conserved

Stabilising selection (Balancing selection) favours average sized individuals while eliminates small sized individuals. It maintains the mean value from generation to generation.

Directional selection (Progressive selection) favours small or large-sized individuals and the population changes towards one particular direction.

Disruptive selection (Diversifying selection) favours both small-sized and large-sized individuals. It eliminates most of the members with mean expression, so produces two peaks in the distribution of the trait that may lead to the development of two different populations.

Fig.: Diagrammatic representation of different types of natural selection

- If disruptive selection results in formation of many new species then it is termed as **adaptive radiation**.

- **Industrial melanism** is an adaptation where the moths living in an industrial area developed melanin pigments to match their body to the tree trunks. It can be explained briefly as follows:

Before industrialisation After industrialisation

  - Before industrialisation, the peppered moth (*Biston betularia*) existed in two forms - light colour (white winged) and melanised (dark winged).
  - Bark of the trees in the past, were covered by whitish lichens, so, white moths were unnoticed by predator birds and dark coloured moths were eaten.
  - After industrialisation, tree trunks became dark due to industrial smoke and soot, so the white moths were selectively picked up by birds and black moths remained unnoticed. This resulted in increase in population of black moths and decrease in population of white moths.
  - Thus, industrial melanism supports evolution by natural selection.

IV. **Isolation :** it is the prevention of mating amongst interbreeding groups due to **physical**, (*i.e.*, geographical, ecological) and **biotic**, (*i.e.*, physiological, behavioural, genetic, mechanical) barriers.

- **Reproductive isolation** is the prevention of interbreeding between the two populations of two different species. Thus, it preserves the integrity of a species by checking hybridisation although it may lead to the origin of a new species by accumulating variations in a population.

V. **Speciation :** The populations of species separated by geographical and physiological barriers, accumulate different genetic differences (variations) due to mutations, recombination, hybridisation, genetic drift and natural selection. These populations undergo morphological and genetic differentiation, become reproductively isolated and form new species.

- Speciation is of following types:
  - **Allopatric speciation :** A part of the population becomes geographically separated from the main population and gradually forms a new species. *E.g.*, Darwin's finches in Galapagos Islands.
  - **Sympatric speciation :** It occurs without geographical isolation. A small segment of the original population becomes isolated reproductively, a new subspecies emerges and gradually a new species is formed.

- **Parapatric speciation :** It occurs when a population of a species enters a new niche or habitat. It results in barrier of gene flow between the populations of new niche and two species are formed due to reproductive isolation.
- **Quantum speciation :** The budding off of a new and very different daughter species from a semi-isolated peripheral population of the ancestral species.

HARDY-WEINBERG PRINCIPLE

- It was proposed by **G.H.Hardy** and **W.Weinberg** in 1908. It describes a theoretical situation in which a population is undergoing no evolutionary change.
- The Hardy - Weinberg Principle states that "the relative frequencies of various kinds of genes and their alleles in a large and randomly mating sexual panmictic population tend to remain constant from generation to generation in the absence of mutation, selection and gene flow." This is called **genetic equilibrium**.
- In a population at equilibrium, for a locus with two alleles D and d, having frequencies of p and q respectively, the genotype frequencies are : DD = p^2, Dd = 2pq and dd = q^2.
- The allele frequency is p + q = 1 and genotype frequency is $p^2 + 2pq + q^2 = 1$, where,

  p = Frequency of the dominant allele in the population.

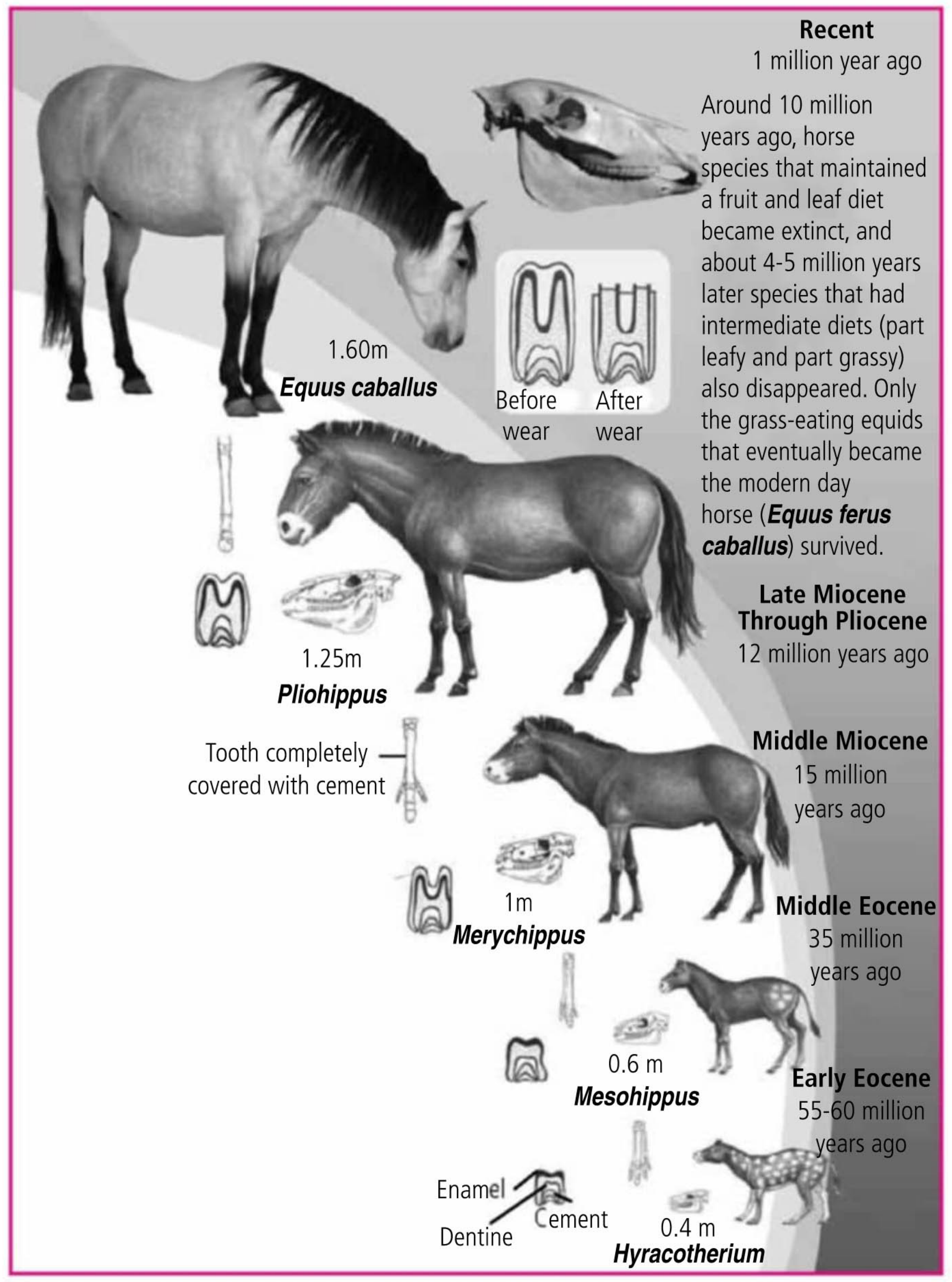
  q = Frequency of the recessive allele in the population.

  p^2 = Percentage of homozygous dominant individual.

  q^2 = Percentage of homozygous recessive individual.

  2pq = Percentage of heterozygous individuals.

  1 = Sum total of all allelic frequencies.
- The gene frequency will remain static only in the absence of evolutionary forces like – mutation, gene flow, selection pressure, genetic drift, recombination and migration.



Around 10 million years ago, horse species that maintained a fruit and leaf diet became extinct, and about 4-5 million years later species that had intermediate diets (part leafy and part grassy) also disappeared. Only the grass-eating equids that eventually became the modern day horse (***Equus ferus caballus***) survived.

Table : **Brief account of evolution**

		Evolution of Plants	Evolution of Animals
Cenozoic	Quaternary	Age of herbs	Modern man dominant
	Tertiary	Age of angiosperms	Evolution of primitive man
Mesozoic	Cretaceous	Ferns and gymnosperms began to decline	Rise of modern fishes and birds
	Jurassic	Origin of angiosperms	Age of reptiles
	Triassic	Abundance of ferns, conifers	Origin of mammals
Paleozoic	Permian	Origin of conifers	Origin of mammal like reptiles
	Carboniferous	Abundance of tree, ferns	Age of amphibians
	Devonian	Earliest mosses and ferns, first seed plants appeared	Age of fishes
	Silurian	Earliest spore bearing plants	Origin of jawed fishes
	Ordovician	First land plants	Origin of vertebrates
	Cambrian	All algal groups	Age of invertebrates. First fossils of vertebrates were found.

HUMAN EVOLUTION

- The emergence of *Homo sapiens*, as a distinct species from other hominids, apes and placental mammals is called **anthropogenesis** or **hominisation**.

Table : **Summary of human phylogeny**

	Name	Age of appearance	Cranial capacity cm^3(cc)	Food/Posture	Important features
1.	*Dryopithecus africanus* (earliest fossil ape)	15 million years, (Miocene)	—	Soft fruits, leaves, knuckle walker	Muzzle and canines large, arms and legs equal-sized
2.	*Ramapithecus* (earliest hominid fossil)	14-15 million years, (Miocene)	—	Seeds, nuts	Canines small, molars large, arboreal, man like dentition, walked like gorilla and chimpanzees etc.
3.	*Australopithecus africanus* (first ape-man)	5 million years, (Pliocene)	500	Essentially ate fruits, fully erect, 1.5 m tall.	Human like teeth, bipedal locomotion, omnivorous diet
4.	*Homo habilis* — (The first hominid tool maker)	2 million years, (Pleistocene) Early in Africa	700	Probably did not eat meat, fully erect	Canines small, first tool maker hunted large game, bipedal gait, cave-man led community life
5.	*Homo erectus* - (The erect man) (Java man)	1.5 million years, (Mid Pleistocene)	800-1300	Probably ate meat 1.5-1.8m tall	Thick, low forehead; brow ridges, used tools made of stones and bones hunted big game, knew use of fire
6.	*Homo sapiens neanderthalensis* – (The Neanderthal man) (First civilised man)	100,000 to 40,000 years, (Late Pleistocene)	~1400	Omnivorous, 1.5-1.66 m tall	Cave dweller, made flint flake tools, used hides as clothes, buried the dead, speech centres had developed, used syllabic language, prognathous face, chin absent
7.	*Homo sapiens fossilis* – (The fossil modern man or Cro-Magnon man)	34,000 years (Holocene)	1650	Omnivorous, 1.8m	Strong jaws with teeth close together, wisdom teeth, cave-dweller, paintings and carvings in caves, had art and culture, orthognathous face, broad pelvic basin, prominent chin
8.	*Homo sapiens sapiens* – (The living modern man)	25,000 years (Holocene)	Approx. 1450	Omnivorous, 1.5-1.8m	Backbone with 4 curves; most intelligent; has art, culture, language, speech.

HOMOLOGY IN CHROMOSOMES OF MAN AND GREAT APES

- Each human somatic cells contains 46 chromosome (44 autosomes + 2 sex chromosomes) while each somatic cell of gorilla, chimpanzee, etc., has 48 chromosomes. The chromosomes obtained from a cell such as WBCs are treated with specific stains to produce banding patterns characteristic to specific chromosomes.
- The banding pattern suggests the structure of chromosomes and the comparison of banding patterns of individual chromosome of humans and ape.
- The banding patterns of human chromosome number 3 and 6 shows a common origin for man and chimpanzee.

Evidences showing common origin of man and ape

Chromosomal similarities
Show similar banding patterns for chromosome number 3 and 6 in both humans and apes.

Blood proteins
The proteins present in blood of humans are similar to those present in chimpanzee and gorilla.

Blood groups
Presence of blood groups A and B in apes (not in monkeys) indicate a closer relationship with man.

Haemoglobin
There is 99% homology in haemoglobin of man and gorilla, suggesting their common origin.

INTEXT PRACTICE QUESTIONS

4. **What is Sewall Wright Effect?**
5. **In which type of the selection, the population changes towards one particular direction?**
6. **Which period signifies the first appearance of land plants?**

MONTHLY TEST DRIVE

XII

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Series 4: Molecular Basis of Inheritance

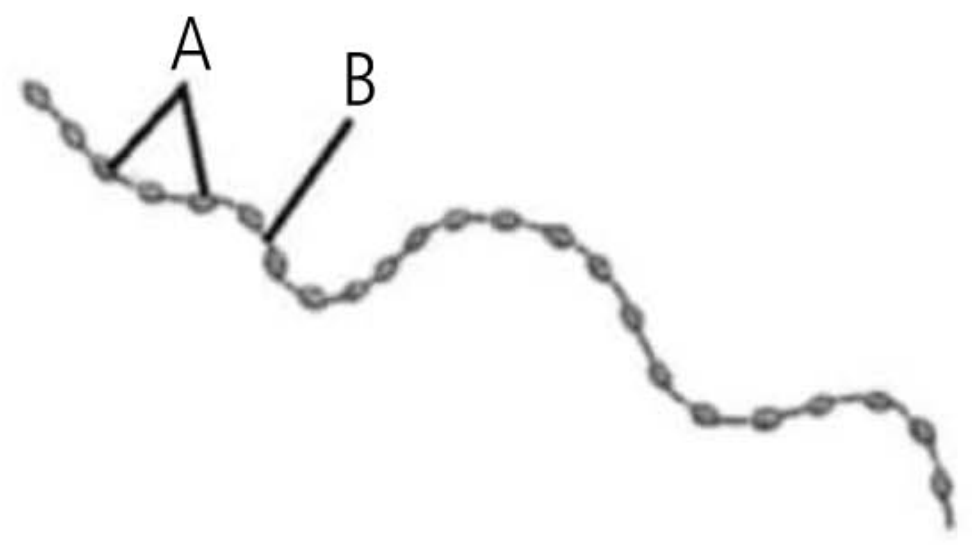
Total Marks : 160 **Time Taken : 40 Min.**

1. Which of the following statement is wrong with regard to B DNA?
- (a) Basic pairs per turn of helix is 10.
- (b) The pitch of helix per turn is 34Å.
- (c) The diameter of DNA helix is 20Å.
- (d) In DNA, the successive nucleotides occur at intervals of 3.8Å.

2. In a 3.6 kbp long piece of DNA, 920 adenine bases were found. What would be the number of cytosine bases?
- (a) 880 (b) 1760
- (c) 920 (d) 360

3. Select the incorrect statement with regard to transcription.
- (a) Template strand takes part in transcription.
- (b) Template strand has 5′→ 3′ polarity.
- (c) Coding strand is also called sense strand.
- (d) Coding strand plays no role in transcription.

4. Refer to the given figure and select the correct option regarding its parts labelled as A, B.



- (a) A-Nucleosome, B-Chromatosome
- (b) A-Linker DNA, B-Chromatosome
- (c) A-Nucleosomes, B-Linker DNA
- (d) A-Chromatosome, B-Linker DNA

5. In purine, nitrogen is present at
- (a) 1, 3, 7 and 9 positions (b) 1 and 3 positions
- (c) 1, 7 and 9 positions (d) 1, 3 and 9 positions.

6. Each intron starts with _____ and ends with _______ respectively.
- (a) GU and AG (b) AG and GU
- (c) AU and AG (d) AU and GA

7. According to the Meselson and Stahl experiment, if DNA of *Escherchia coli* was extracted after 60 minutes in the $^{14}NH_4Cl$ medium. What would be the DNA densities?
- (a) 75% light ($N^{14}N^{14}$) and 25% hybrid ($N^{15}N^{14}$)
- (b) 15% light ($N^{14}N^{14}$) and 85% hybrid ($N^{15}N^{14}$)
- (c) 50% light ($N^{14}N^{14}$) and 50% hybrid ($N^{15}N^{14}$)
- (d) 25% light ($N^{14}N^{14}$) and 75% hybrid ($N^{15}N^{14}$)

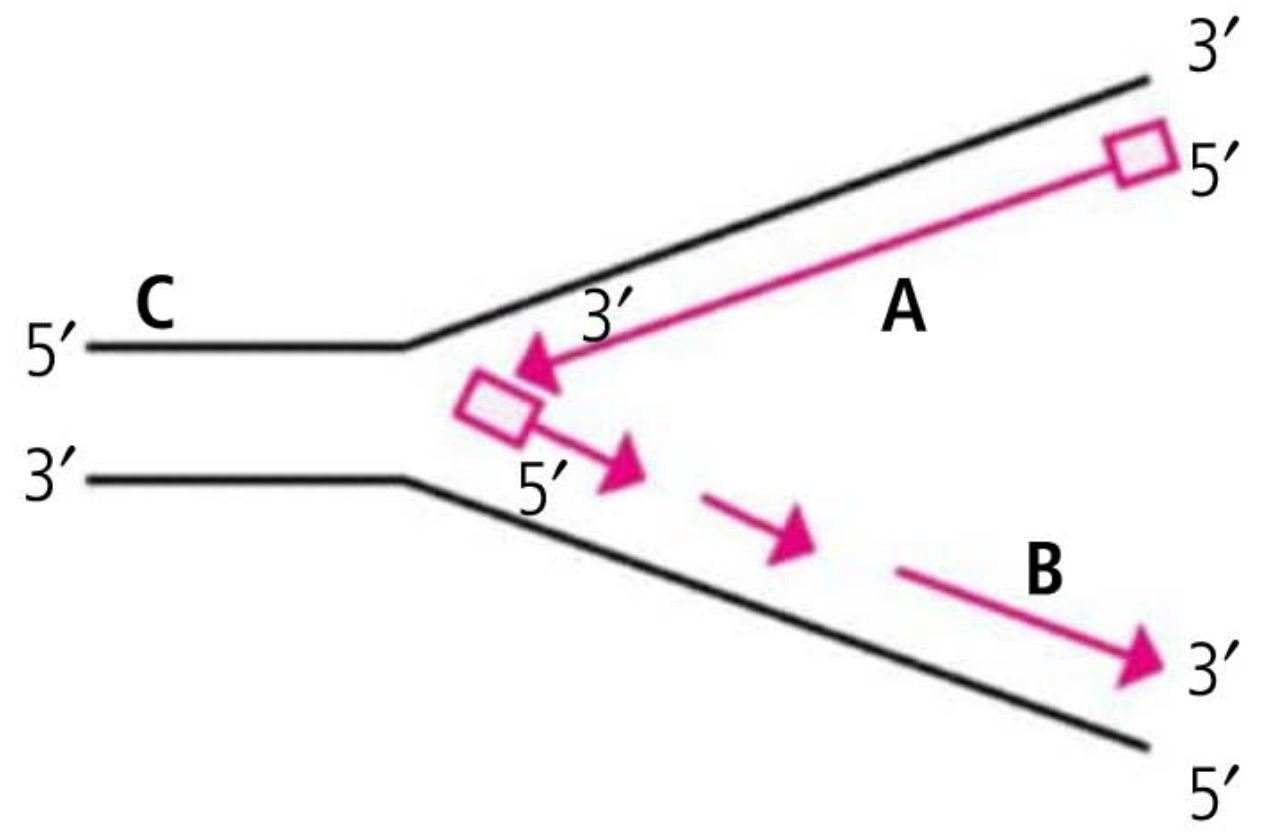
8. Which of the following criteria is not mandatory for a molecule to act as a genetic material?
- (a) It should be able to generate its replica.
- (b) It should be chemically and structurally stable.
- (c) It should provide scope for mutation to facilitate evolution.
- (d) It should destroy itself after every cell cycle.

9. Select the correct sequence of DNA replication.
- (a) Origin of replication → Activation of deoxyribonucleotides → Exposure of parent DNA strands → Synthesis of RNA primer → Base pairing → New strand formation → Proof reading.
- (b) Origin of replication → Activation of deoxyribonucleotides → Synthesis of RNA primer → Exposure of parent DNA strands → Base pairing → New strand formation → Proof reading.
- (c) Activation of deoxyribonucleotides → Exposure of parent DNA strands → Origin of replication → Synthesis of RNA primer → Base pairing → New strand formation → Proof reading.
- (d) Exposure of parent DNA strands → Activation of deoxyribonucleotides → Synthesis of RNA primer → Origin of replication → Base pairing → Proof reading → New strand formation.

10. Given below are few statements regarding 'Hershey and Chase' experiment proving DNA is genetic material. Choose the incorrect statements.
- (i) They used rats for the experiments.
- (ii) Bacteriophage T_4 was used.
- (iii) Bacterium *Streptococcus pneumoniae* namely, S-III strain and R-II strain were used.
- (iv) The culture was supplemented with radio-active sulphur ^{35}S.
- (v) Density gradient centrifugation was used.

- (a) (i), (ii) and (iv) only (b) (i), (ii) and (iii) only
- (c) (i) and (iii) only (d) (i) and (iv) only

11. Identify A, B and C in the given figure of DNA replication fork.



- (a) A-Discontinuous strand, B-Continuous strand, C-Parental strand.
- (b) A-Leading strand, B-Lagging strand, C-Parental strand.
- (c) A-Lagging strand, B-Leading strand, C-Template strand.
- (d) A-Lagging strand, B-Leading strand, C-Continuous strand.

12. Select the correctly matched pair.
- (a) Neomycin – inhibits initiation of transcription
- (b) Puromycin – inhibits peptidyl transferase
- (c) Actinomycin – inhibits RNA synthesis by inhibiting RNA polymerase
- (d) Erythromycin – inhibits binding of aminoacyl *t*RNA to ribosome

13. Select the incorrect statement regarding DNA polymerases.
- (a) DNA polymerase was discovered by Kornberg.
- (b) Eukaryotes have five types DNA polymerases - $\alpha, \beta, \gamma, \delta$ and ε.
- (c) DNA polymerase I is mainly responsible for DNA replication in *E.coli*.
- (d) DNA polymerase I is also called Kornberg enzyme.

14. The subunits of DNA polymerase III are
- (a) $\alpha, \beta, \delta, \varepsilon$ (b) $\alpha, \beta, \delta, \varepsilon, \theta$
- (c) $\beta, \delta, \gamma, \varepsilon$ (d) $\alpha, \beta, \delta, \gamma, \varepsilon, \theta, \tau$.

15. Read the given statements and select the correct option.

Statement A : Lagging strand is a replicated strand of DNA which is formed in short segments called Okazaki fragments.

Statement B : The direction of growth of the lagging strand is 5′→ 3′ though in each Okazaki fragment is 3′→ 5′.

- (a) Statement A is correct but statement B is incorrect.
- (b) Statement A is incorrect but statement B is correct.
- (c) Both statements A and B are correct.
- (d) Both statements A and B are incorrect.

16. The sequence of nitrogen bases in one strand of DNA are 3′ TAAGCGATA 5′. The complementary DNA strand should have
- (a) 5′ ATTCCCTAT 3′ (b) 5′ ATTCGCTAT 3′
- (c) 3′ ATTCGCTAT 5′ (d) 5′ TAAGCGATA 3′.

17. In eukaryotes, RNA polymerase III is responsible for transcription of
- (a) *r*RNA
- (b) *t*RNA, 5S*r*RNA and some snRNAs
- (c) hnRNA, 5S*r*RNA and snRNAs
- (d) snRNAs.

18. In prokaryotic RNA polymerase, the sigma factor (σ) is involved in _______ whereas rho (ρ) factor is involved in _______.
- (a) initiation of *m*RNA synthesis, elongation
- (b) initiation of *m*RNA synthesis, translation
- (c) initiation of *m*RNA synthesis, termination of transcription
- (d) elongation, termination of transcription.

19. Select the correct statement regarding RNA processing.
- (a) In tailing, polyadenine tail is added at 3′ end of hnDNA.
- (b) In capping, methyl guanosine triphosphate is added to 3′ end of hnRNA.
- (c) Three types of RNA polymerases catalyse the transcription of three different types of RNAs in most bacteria.
- (d) RNA polymerase I transcribes *t*RNA in eukaryotes.

20. Match column I with column II and select the correct option from the below given codes.

	Column I		Column II
A.	RNA polymerase-I	(i)	Methyl guanosine triphosphate
B.	Core enzyme	(ii)	AT rich region
C.	TATA box	(iii)	Transcribes *r*RNAs
D.	rho (ρ) factor	(iv)	Elongation of *m*RNA chain
E.	Capping at 5′ end	(v)	Termination
		(vi)	Initiation of RNA synthesis

- (a) A-(iii), B-(iv), C-(ii), D-(i), E-(v)
- (b) A-(iii), B-(v), C-(ii), D-(iv),E-(i)
- (c) A-(i), B-(iv), C-(ii), D-(vi),E-(iii)
- (d) A-(iii), B-(iv), C-(ii), D-(v), E-(i)

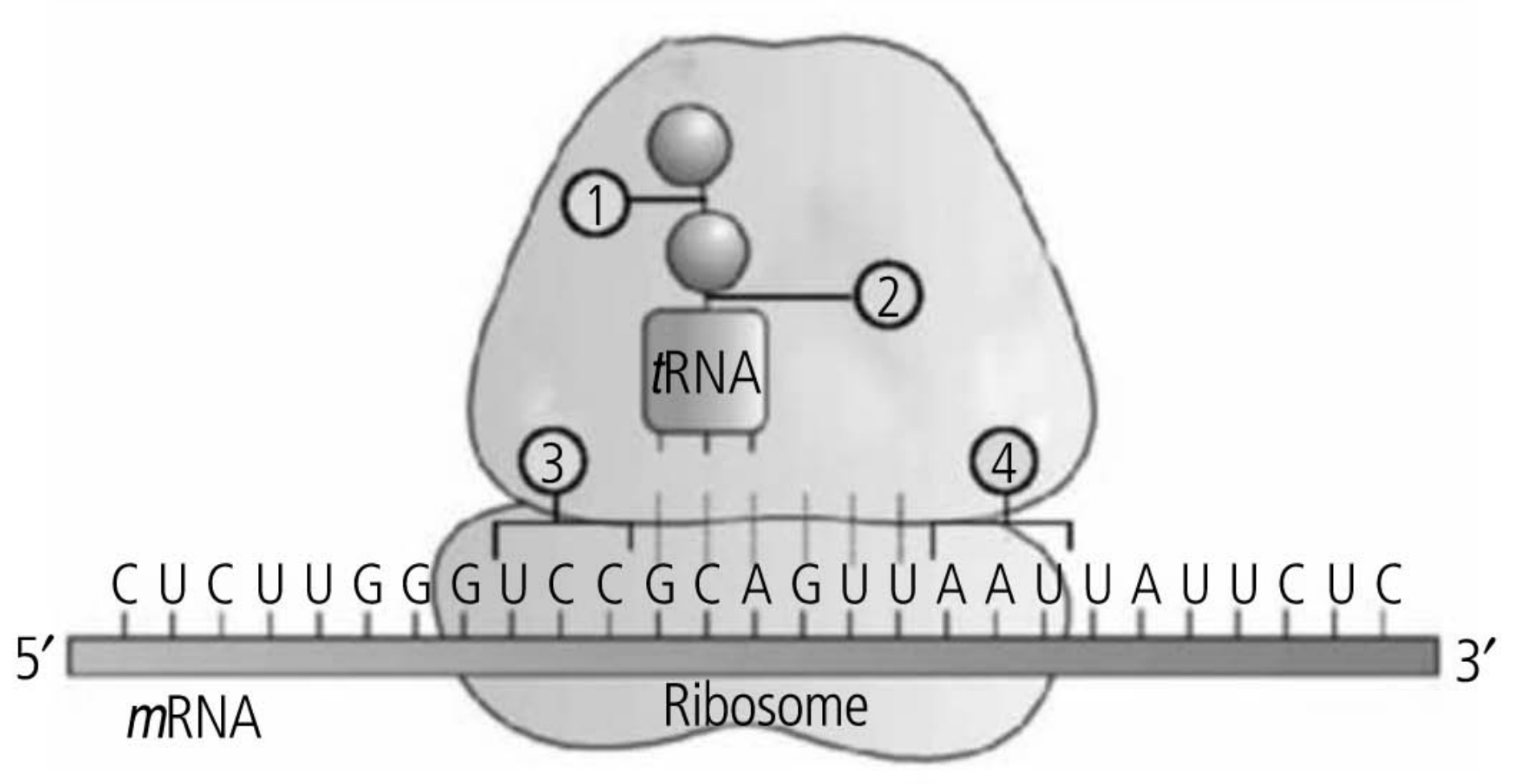
21. Identify the type of gene from the given characters.
- (i) It is a region on DNA molecules where an RNA polymerase binds.
- (ii) It has AT rich region.

(iii) It has grooves to which specific protein components can combine.
(iv) It is a small gene.

(a) Operator gene (b) Structural gene
(c) Regulator gene (d) Promoter gene

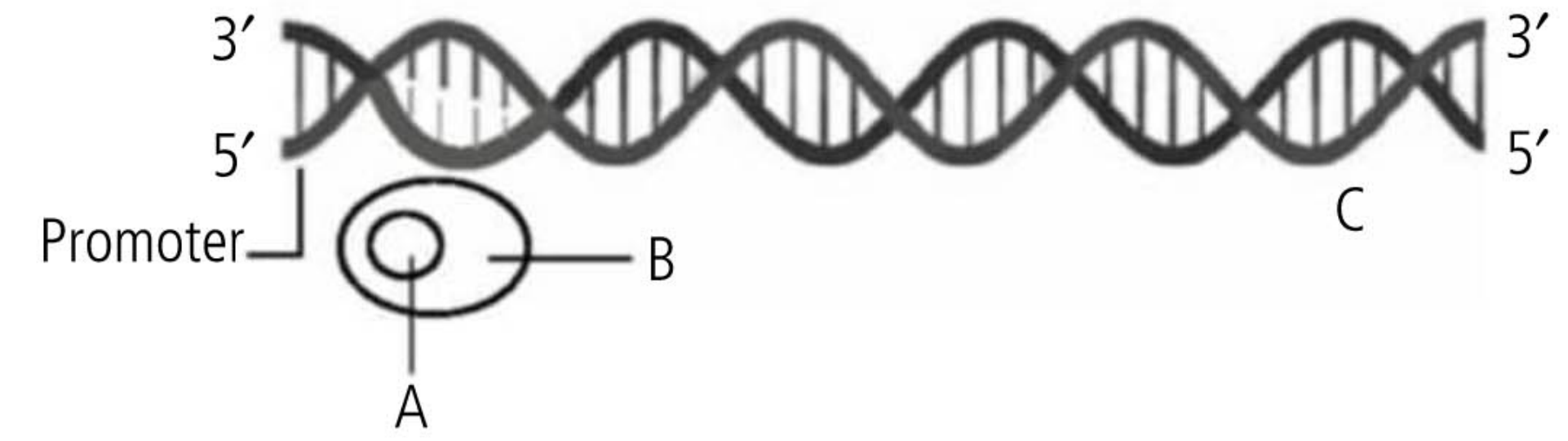
22. In prokaryotes, the enzyme responsible for transcription of RNA is
(a) DNA dependent RNA polymerase
(b) RNA polymerase-I
(c) DNA polymerase
(d) RNA polymerase-II

23. Given figure shows the polypeptide chain formation. Where would alanine bind in polypeptide chain?



(a) 1 (b) 2
(c) 3 (d) 4

24. The given figure shows the process of transcription in bacteria. Identify A, B and C.

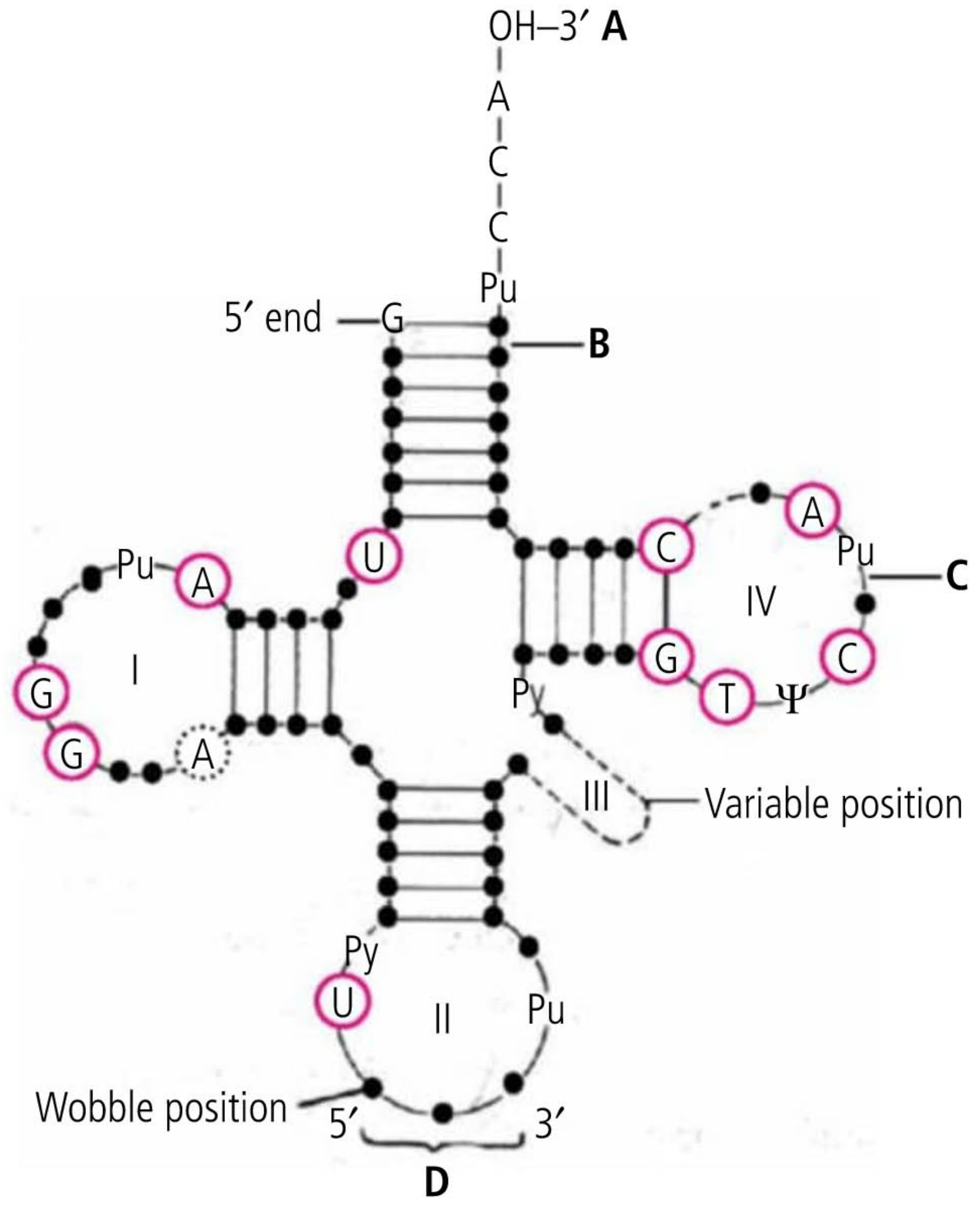


(a) A-rho (ρ) factor, B-DNA polymerase, C-RNA
(b) A-sigma (σ) factor, B-RNA polymerase, C-DNA
(c) A-Sigma (σ) factor, B-DNA polymerase, C-RNA
(d) A-rho (ρ) factor, B-DNA polymerase, C-DNA

25. Read the given statements.
(i) Prokaryotic transcription occurs in cytoplasm.
(ii) In prokaryotic transcription *m*RNA is generally polycistronic.
(iii) Eukaryotic transcription occurs in G_1 and G_2 phases.
(iv) In prokaryotic transcription, splicing is required for removing introns.
(v) In eukaryotic transcription, three types of RNA polymerase are involved.
(vi) Eukaryotic transcription is coupled to translation.

How many statements are correct?
(a) Two (b) Three
(c) Four (d) Five

26. Identify the labels A, B, C and D in the given structure of *t*RNA and select the correct option.



(a) A-Acceptor stem, B-AA binding site, C-TΨC loop, D-Anticodon loop
(b) A-AA binding site, B-Acceptor stem, C-TΨC loop, D-Anticodon
(c) A-TΨC loop, B-Acceptor stem, C-AA binding site, D-Anticodon
(d) A-AA binding site, B-TΨC loop, C-Acceptor stem, D-Anticodon

27. Which of the following represents the correct sequence of RNAs according to their abundance in cell?
(a) *r*RNA > *t*RNA > *m*RNA
(b) *m*RNA > *r*RNA > *t*RNA
(c) *r*RNA > *m*RNA > *t*RNA
(d) *m*RNA > *t*RNA > *r*RNA

28. Why aminoacylation of *t*RNA is important?
(a) It is essential for the replication of RNA.
(b) It initiate transcription.
(c) It provide the energy required for the formation of peptide bond.
(d) It is essential for splicing of introns.

29. Match the following columns and select the correct option.

	Column I		**Column II**
P.	Initiation codon	(i)	Arginine
Q.	UGG	(ii)	Cysteine
R.	UGC	(iii)	Tryptophan
S.	Redundant codon	(iv)	Methionine

(a) P-(iv), Q-(iii), R-(ii), S-(i)
(b) P-(iv), Q-(ii), R-(iii), S-(i)
(c) P-(iv), Q-(i), R-(iii), S-(ii)
(d) P-(i), Q-(iii), R-(ii), S-(iv)

30. Which of the following codons code for lysine, proline and valine amino acids respectively?
(a) CUU, GUC and AAA (b) AAA, CCU and GUU
(c) CGU, GGC and ACU (d) CCU, GUU and ACU

31. Select the correct constituents of larger subunit of eukaryotic ribosome.
(a) 23S, 16S, 5S (b) 23S, 18S, 5S
(c) 28S, 16S, 5S (d) 28S, 5.8S, 5S

32. Select the correct sequence of *t*RNA attachment site on ribosome during initiation of polypeptide chain formation.
(a) P-site ⟶ A-site ⟶ E-site
(b) E-site ⟶ A-site ⟶ P-site
(c) P-site ⟶ E-site ⟶ A-site
(d) E-site ⟶ P-site ⟶ A-site

33. The codon-anticodon reaction occurs in the presence of initiation factor ______ in eukaryotic and ______ in prokaryotes respectively.
(a) eIF3, IF3 (b) eIF3, IF2
(c) eIF4, IF2 (d) eIF3, IF1

34. Given below is the steps of translation process in eukaryotes.

A. $\text{AA} + \text{ATP} + \text{E} \xrightarrow{\text{(i)}} \text{AA} \sim \text{AMP} - \text{E} + \text{PPi}$

B. $\text{AA} \sim \text{AMP} - \text{E} + t\text{RNA} \longrightarrow \text{(ii)} + \text{AMP} + \text{E}$

C. $\text{40S subunit} + m\text{RNA} \xrightarrow{\text{(iii)}} \text{40S} - m\text{RNA}$

D. $\text{40S} - m\text{RNA} + t\text{RNA}^{\text{Met}} \xrightarrow[\text{GTP}]{\text{(iv)}} \text{40S-}m\text{RNA-}t\text{RNA}^{\text{Met}}$

E. $\text{40S} - m\text{RNA} - t\text{RNA}^{\text{Met}} + \text{60S} \xrightarrow{\text{(v)}} \text{80S} - m\text{RNA} - t\text{RNA}^{\text{Met}}$

Select the option that correctly identifies (i – iv).
(a) (i) ATP, (ii) AA-*t*RNA, (iii) eIF3, (iv) eIF4, (v) eIF1
(b) (i) Mg^{2+}, (ii) AA-*t*RNA, (iii) eIF3, (iv) eIF2, (v) eIF1
(c) (i) Mg^{2+}, (ii) AA-*t*RNA, (iii) eIF2, (iv) eIF3, (v) eIF1
(d) (i) Mg^{2+}, (ii) AA-*t*RNA, (iii) eIF3, (iv) eIF1, (v) eIF2

35. Which one of the following is most abundant protein in *E.coli*?
(a) EF-Ts (b) eIF3 (c) EF-Tu (d) eIF1

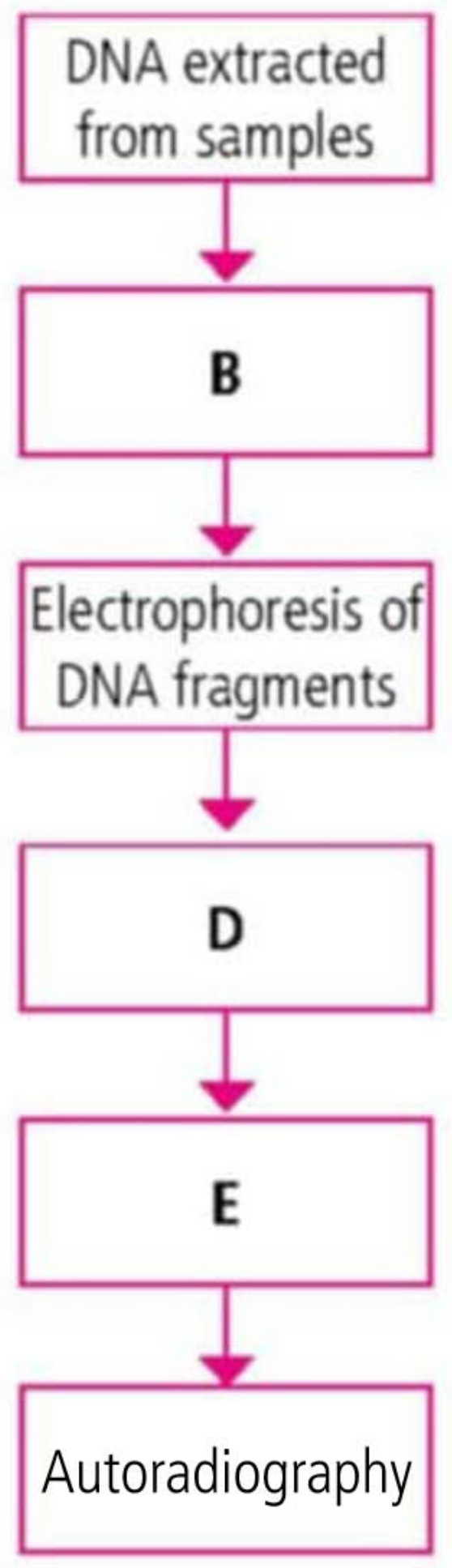
36. The first amino acid that is incorporated in the eukaryotic polypeptide is
(a) methionine (b) arginine
(c) valine (d) tryptophan.

37. Which of the following is incorrect for *lac* operon?
(a) The structural genes are *lac z, y* and *a*, where *z* gene is responsible for hydrolysis of disaccharides.
(b) It is an inducible operon and controls catabolic reactions.
(c) The *lac* operon is switched off when repressor protein binds to operator gene.
(d) Operator gene possess site for RNA polymerase attachment.

38. Select the mismatched pair.
(a) β-galactosidase – Hydrolysis of disaccharides
(b) Permease – Increase permeability to β-galactosidase
(c) Transacetylase – Transfer acetyl group to β-galactoside
(d) Regulator gene – Codes for inducer protein

39. Sequence annotation refers to
(a) genes expressed as RNA
(b) polypeptide expressions
(c) identification of all the gene expressed as RNA
(d) Process of marking specific features in a RNA, DNA or protein sequence with descriptive information about structure and function.

40. Some of the steps of DNA fingerprinting are given in flow chart. Select the option that correctly fills the missing steps.



(a) B-Digestion of DNA by restriction enzymes, D-Blotting of DNA fragments to nitrocellulose membrane, E-Hybridisation with DNA probe.
(b) B-Blotting of DNA fragments to nitrocellulose membrane, D-Hybridisation with DNA probe, E-Digestion of DNA by restriction enzymes.
(c) B-Digestion of DNA by restriction enzymes, D-Hybridisation with DNA probe, E-Blotting of DNA fragments to nitrocellulose membrane.
(d) B-Blotting of DNA fragments to nitrocellulose membrane, D-Digestion of DNA restriction enzymes, E-Hybridisation with DNA probe.

☺☺

Key is published in this issue. Search now! ☺

SELF CHECK

Check your score! If your score is

No. of questions attempted ......
No. of questions correct ......
Marks scored in percentage ......

> 90%	**EXCELLENT WORK !**	**You are well prepared to take the challenge of final exam.**
90-75%	**GOOD WORK !**	**You can score good in the final exam.**
74-60%	**SATISFACTORY !**	**You need to score more next time.**
< 60%	**NOT SATISFACTORY!**	**Revise thoroughly and strengthen your concepts.**

CBSE warm-up!

CLASS-XII

Chapterwise Practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2019-20.

GENERAL INSTRUCTIONS

(i) There are a total of 27 questions and four sections in the question paper. All questions are compulsory.

(ii) Section A contains question numbers 1 to 5, very short-answer type questions of 1 mark each.

(iii) Section B contains question numbers 6 to 12, short-answer type I questions of 2 marks each.

(iv) Section C contains question numbers 13 to 24, short-answer type II questions of 3 marks each.

(v) Section D contains question numbers 25 to 27, long-answer type questions of 5 marks each.

(vi) There is no overall choice in the question paper, however, an internal choice is provided in two questions of 1 mark, two questions of 2 marks, four questions of 3 marks and all the three questions of 5 marks. In these questions, an examinee is to attempt any one of the two given alternatives.

Wherever necessary, the diagram drawn should be neat and properly labelled.

UNIT - VII

- **Principles of Inheritance and Variation**
- **Molecular Basis of Inheritance**
- **Evolution**

Time Allowed : 3 hours

Maximum Marks : 70

SECTION - A

1. Name the type of cross that would help to find out the genotype of a pea plant having green pods.

OR

Give two examples of adaptive radiation.

2. During a dihybrid cross, Morgan found out that the proportion of parental gene combination was much higher than the non-parental types. What could be the reason behind his finding?

3. Name the two basic amino acids that imparts positive charge to histone proteins.

OR

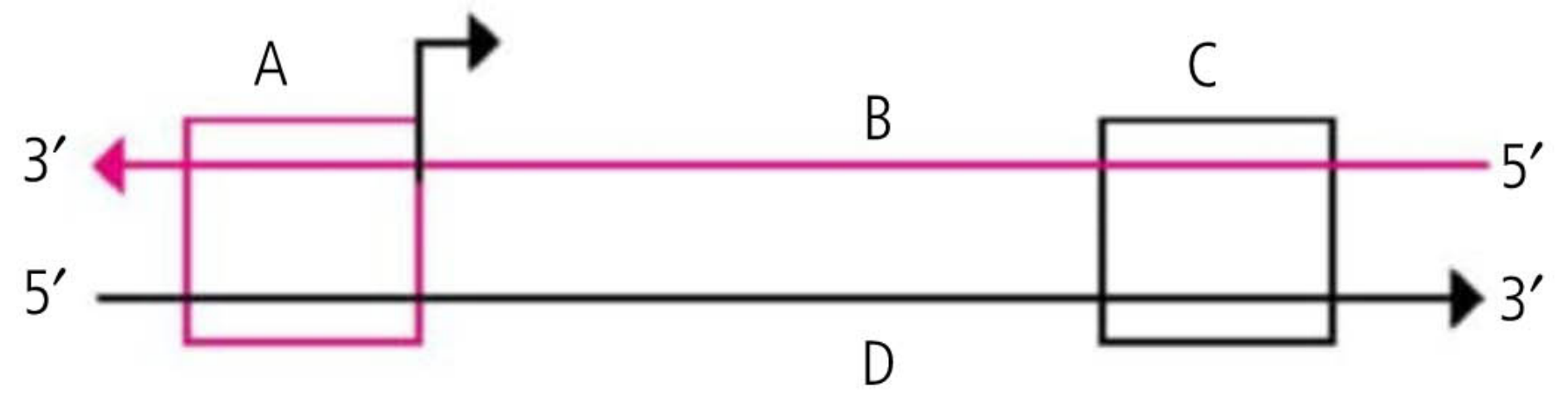
Name the gas that was absent during the formation of earth.

4. In a sea animal, the double stranded DNA contains 20% cytosine of the total bases. What would be the percentage of thymine?

5. What are the two key concepts of Darwinian theory of evolution?

SECTION - B

6. Name the parts 'A', 'B', 'C' and 'D' of the transcription unit given below.



OR

Write down the functions of the following in a prokaryote:

(i) *t*RNA, (ii) *r*RNA

7. Colourblindness is a sex linked recessive disease, that shows its transmission from unaffected carrier female to some of the male progeny. Why the possibility of a female becoming a Colourblind is extremely rare?

8. What are analogous organs? Give two examples.

9. Is it correct to blame the mother for bearing a female child? Yes or No? Justify your answer.

OR

During amniocentesis, fetus was found to possess an extra chromosome 21. Name the chromosomal disorder. Also mention the symptoms that fetus is likely to develop later in the life.

10. Write down the differences between divergent evolution and convergent evolution.

11. When a true-breeding red flowered (RR) plants were crossed with a true–breeding white flowered (rr) plants, the F_1 progeny did not show any of the parental traits. Explain why.

12. Discuss the roles of following enzymes:

(i) DNA ligase

(ii) DNA-dependent DNA polymerase

SECTION - C

13. The sequence of the coding strands of DNA in a transcription unit is mentioned below:

5′ AATGCAGCTATTAGG 3′

(a) Write down its complementary strand.

(b) Write the sequence for the *m*RNA transcribed from this.

(c) Explain the base complementarity rules.

14. The F_1 generation obtained from a monohybrid cross between a tall pea plant and a dwarf pea plant showed an equal ratio of tall and dwarf offsprings. Explain it with the help of Punnett square.

OR

Explain Hardy-Weinberg principle. List any four factors which affect the genetic equilibrium.

15. Draw a labelled diagram of replication fork of DNA. Also explain the role of the enzymes involved in DNA replication.

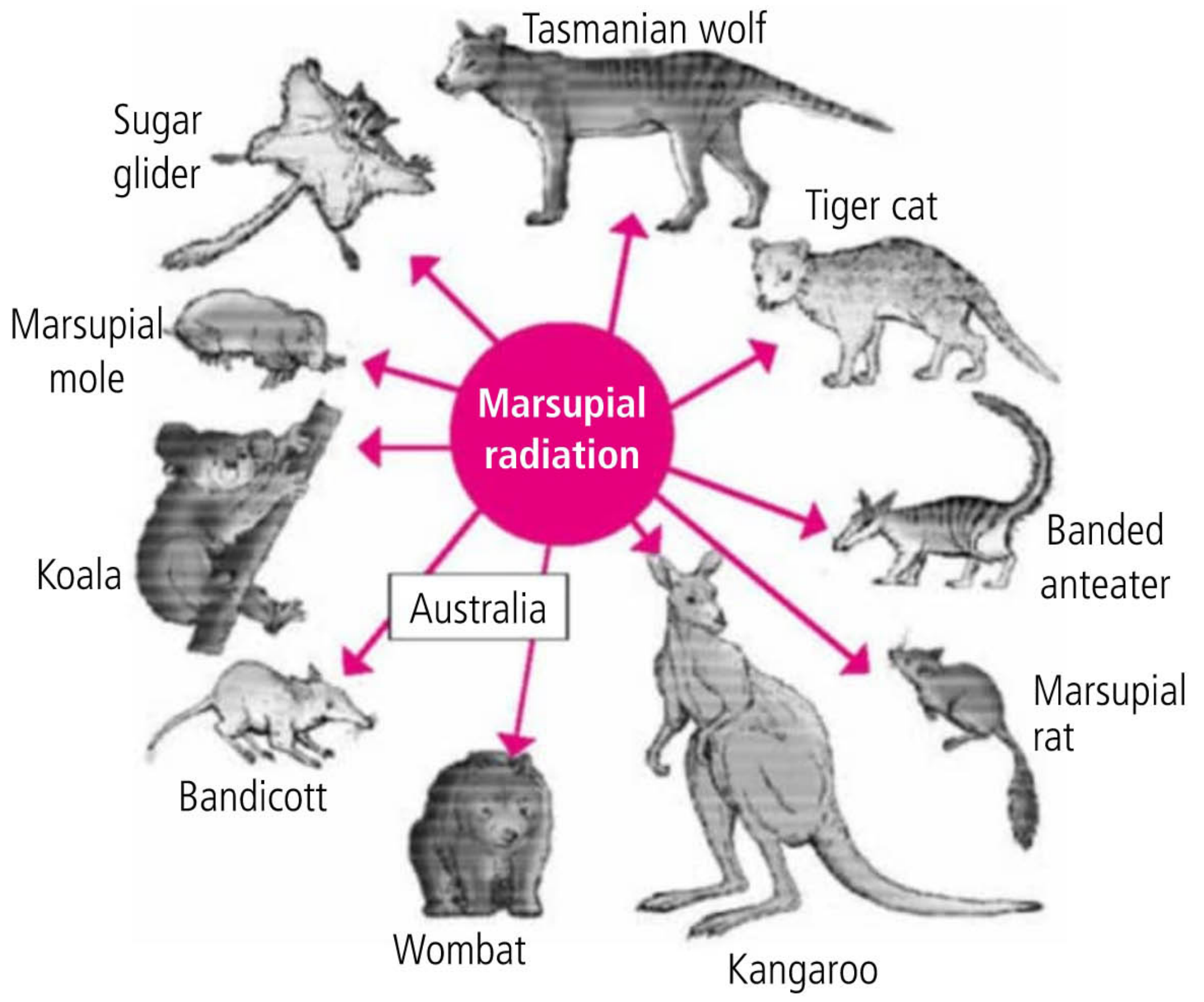
16. What is male heterogamety? Give two examples of organism where male heterogamety can be found. How do male heterogamety differs from female heterogamety?

17. In 1928, Frederick Griffith, in a series of experiments with *Streptococcus pneumoniae*, witnessed miraculous transformation in the bacteria.

(a) What were the various steps of Griffith's experiments that led to the conclusion of the transforming principle?

(b) Name the three scientists who followed up Griffith's experiment.

18. With reference to the given figure, answer the following questions:



(a) Name the evolutionary concept represented in the above figure.

(b) Where are these organisms found?

(c) Explain the phenomenon that has resulted in the evolution of such diverse species in the region.

OR

Define the following:

(a) Founder effect

(b) Genetic drift

(c) Convergent evolution

19. List four main propositions of Lamarck.

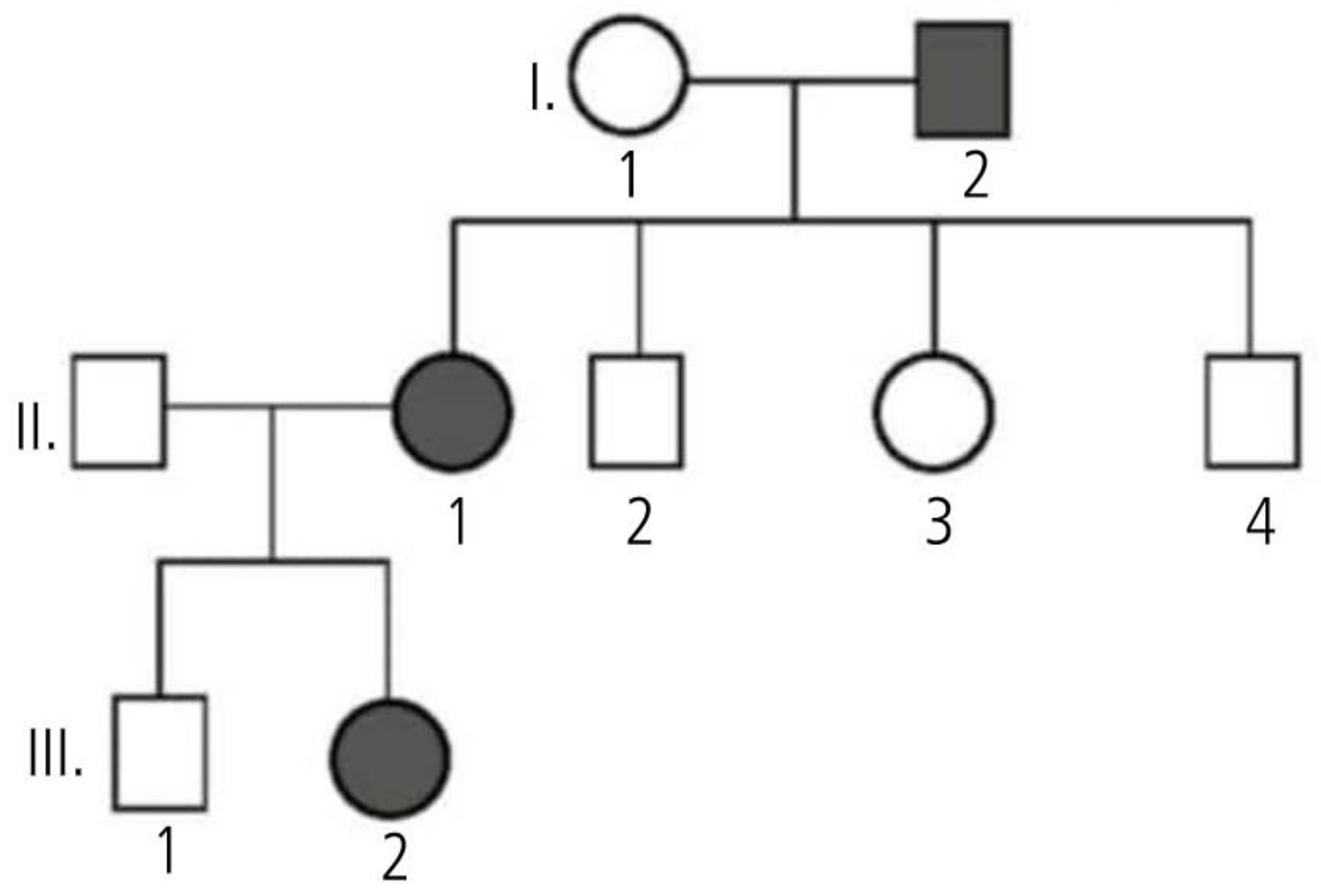
OR

What is complete linkage? What are the differences between complete linkage and incomplete linkage?

20. Explain the mechanism of sex-determination in *Drosophila*.

21. Draw a schematic labelled illustration of *lac* operon in a 'switched on' state. How would *lac* operon operate in *E.coli* growing in a culture medium where lactose is present as source of sugar?

22. Study the given pedigree chart showing the inheritance of fused ear lobe in a family and answer the questions given.



Identify the genotype of the following:
(i) I - 1; **(ii)** II - 1; **(iii)** II - 2

OR

(a) Name the genetic disorder in a human male having 44 + XXY karyotype. Mention the diagnostic features of this disorder.

(b) What is the cause of such chromosomal disorder?

23. In an industrial area, it was observed that white winged moths were replaced by the dark winged moths. Explain this observation.

24. Write three characteristics of *Ramapithecus* and Neanderthal man.

SECTION - D

25. Rahul was walking in a garden where he found a tall pea plant bearing violet flowers. He became curious about its genotype. How can Rahul find out the genotype of this plant?

OR

(a) Differentiate between homologous and analogous organs. How do they support evolution?

(b) Explain the theory of biogenesis.

26. **(a)** Darwin during his visit to Galapagos island found variation in beaks of small black birds inhabiting there. Explain the phenomenon that is well represented by these small black birds other than natural selection.

(b) How the Australian marsupials are suitable example of adaptive radiation as well as divergent evolution? Explain.

OR

(a) A haemophilic man marries a normal women but the disease does not appear in any of the immediate offspring. Explain why? Work out a cross to show how it is possible.

(b) What are symptoms of haemophilia?

27. Explain the process of transcription in prokaryotes.

OR

(a) Explain the initiation and termination of translation process in prokaryotes.

(b) Define the procedure of processing of hnRNA to become functional *m*RNA in eukaryotes.

SOLUTIONS

1. Test cross is used to determine unknown genotype of an individual.

OR

Darwin's finches and Australian marsupials.

2. In a dihybrid cross when the genes involved are linked, then the proportion of parental gene combinations is much higher than the non-parental types.

3. Lysine and arginine

OR

Oxygen

4. In a double stranded DNA molecule, adenine pairs with thymine and cytosine pairs with guanine. According to Chargaff's rule, purines and pyrimidines occur in equal amounts *viz.* $\frac{A+T}{G+C}=1$. So, if there is 20% cytosine, then there will be 20% guanine. Cytosine and guanine will account for 40% of DNA, therefore, percentage of thymine and adenine will be 60% *i.e.*, adenine = 30%, thymine = 30%.

5. Branching descent and Natural selection.

6. A - Promoter, B - Template strand, C - Terminator, D - Coding strand

OR

(i) *t*RNA helps in transferring the amino acids to ribosome for synthesis of polypeptide chain and acts as an adapter molecule. *t*RNA places specific amino acids at particular points during polypeptide synthesis as per codons of *m*RNA. Codons are recognised by anticodons of *t*RNAs. They hold peptidyl chain over the *m*RNA. The initiator *t*RNA has dual function of initiation of protein synthesis as well as bringing in of first amino acid.

(ii) *r*RNA is the most abundant RNA. Prokaryotic ribosomes contains three types of *r*RNA; 23S, 16S and 5S. 23S and 5S *r*RNA occur in large subunit of ribosome while 16S *r*RNA is found in smaller subunit. It plays structural and catalytic role during translation. *r*RNAs bind protein molecules and give rise to ribosomes.

7. The possibility of a female becoming a colourblind is extremely rare because colourblindness is sex linked recessive disease and a female become colourblind only when both the X chromosomes carry colourblindness gene (X^cX^c), *i.e.*, homozygous recessive. For this purpose the mother of such a female has to be at least carrier and the father should be colourblind.

8. The organs which have similar functions but are different in their structural organisation and origin are called analogous organs.
The examples of analogous organs are :
(i) Stings of honey bee and scorpion.
(ii) Pectoral fins of sharks and flippers of dolphins.

9. In humans, sex of the child is determined at the time of fertilisation. The female parent produces only one type of egg containing X-chromosome. The male gametes are of two types : one with X-chromosome and another with Y-chromosome. Fertilisation of the egg with sperm carrying X-chromosome produces a female child (XX) while fertilisation with sperm carrying Y-chromosome give rise to male child (XY). Thus, sex of the child is determined by father and not by the mother.
Hence, it is scientifically incorrect to blame the mother for bearing a female child.

OR

Trisomy of 21 chromosome causes Down's syndrome. It is an autosomal aneuploidy. It occurs due to the non-disjunction of chromosome 21 at the time of oogenesis. The symptoms that the fetus is likely to develop later in the life are :

(i) The child will have short stature and rounded face, broad forehead, permanently open mouth and protruding tongue.

(ii) The palms of the child will be broad with characteristic palmer crease.

(iii) Physical and mental development will be retarded.

10. Differences between divergent evolution and convergent evolution are as follows:

	Divergent evolution	Convergent evolution
(i)	Development of different functional structures from a common ancestral form is called divergent evolution.	Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution.
(ii)	Homologous organs show divergent evolution.	Analogous organs show convergent evolution.
(iii)	Examples : Darwin's Finches, Australian Marsupials, forelimbs of mammals.	Examples : Australian Marsupials and placental mammals, various aquatic vertebrate and wings of insect, bird and bat.

11. When a true-breeding red flowered (RR) plants were crossed with a true-breeding white flowered (rr) plants, the F_1 progeny did not show any of the parental traits because none of the two alleles of a gene were dominant over each other, so a new phenotype is formed which is intermediate (Rr) between the independent expression of the two alleles. This phenomenon is known as incomplete dominance.

12. **(i)** DNA ligase – It joins the small fragments of DNA of a lagging strand during the DNA replication.

(ii) DNA dependent DNA polymerase – It catalyses the polymerisation of deoxyribonuclotides. It adds nucleotides only in $5' \longrightarrow 3'$ direction thereby resulting in continuous replication on DNA strands with $3' \longrightarrow 5'$ polarity and discontinuous replication on strand with $5' \longrightarrow 3'$ polarity.

13. **(a)** 3′ TTACGTCGATAATCC 5′

(b) 5′ AAUGCAGCUAUUAGG 3′

(c) Base complementary rules or Chargaff's rules are the important generalisations made by Chargaff (1950) on the basis of nitrogenous bases and other components of DNA. These rules are as follows:

(i) Purine and pyrimidine base pairs are in equal amount, that is, adenine + guanine = thymine + cytosine.

$$[A+G]=[T+C],\ \textit{i.e.,}\ \frac{[A+G]}{[T+C]}=1$$

(ii) Molar amount of adenine is always equal to the molar amount of thymine. Similarly, molar concentration of guanine is equal to the molar concentration of cytosine.

$$[A]=[T],\ \textit{i.e.,}\ \frac{[A]}{[T]}=1\ ;\ [G]=[C],\ \textit{i.e.,}\ \frac{[G]}{[C]}=1$$

(iii) Sugar deoxyribose and phosphate occur in equimolar proportions.

(iv) A–T base pairs are rarely equal to C–G base pairs.

(v) The ratio of $\frac{[A+T]}{[G+C]}$ is variable but constant for a species. It can be used to identify the source of DNA. The ratio is low in primitive organism and higher in advanced ones.

14. Two contrasting characters of height are tall and dwarf. In the given cross, if 50% of the progeny shows parental characters, then it must be a cross between a heterozygous tall and a homozygous recessive dwarf parent.

Parent : Tall Dwarf
Genotype : Tt × tt
Gametes : Ⓣ ⓣ ⓣ ⓣ

F_1 generation :

	T	t
t	Tt Tall	tt Dwarf
t	Tt Tall	tt Dwarf

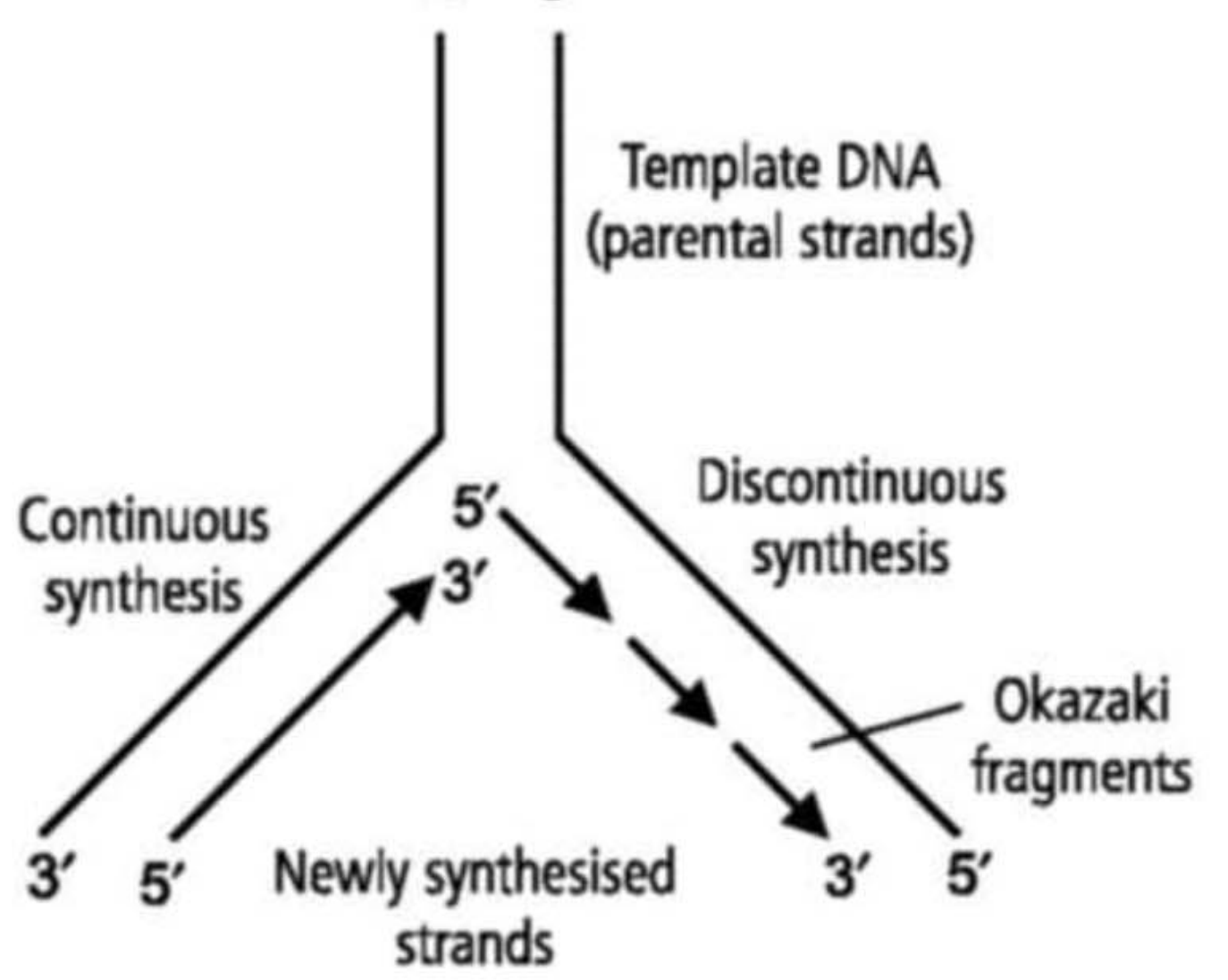
Phenotypic ratio ⇒ Tall : Dwarf = 1 : 1

OR

Hardy-Weinberg equilibrium states that there is a balance in the frequency of alleles from generation to generation within a large population over a period of time assuming that : (i) mating is random; (ii) there is no natural selection; (iii) there is no migration; (iv) there is no mutation. He also stated that sum of all allelic frequency is 1. In such a stable population, for a gene with two alleles, A (dominant) and a (recessive), the frequency of both allele is denoted as p and q respectively. Then the frequencies of the three possible genotypes (AA, Aa, and aa) can be expressed by the equation : $p^2+2pq+q^2=1$.

where p^2 = frequency of AA (homozygous dominant) individuals, $2pq$ = frequency of Aa (heterozygous) individuals, and q^2 = frequency of aa (homozygous recessive) individuals. Factors affecting genetic equilibrium are gene flow, mutation, natural selection and genetic recombination.

15. Schematic representation of replication fork is as follows:



Various enzymes required during DNA replication are helicase, phosphorylase, topoisomerase, DNA polymerase I, II and III, primase and DNA ligase.

Helicase : It acts over the *ori* site and unzips the two strands of DNA.

Phosphorylase : It is required for activation of deoxyribonucleotides through phosphorylation.

Topoisomerase : The tension created by unwinding of double helix is released by topoisomerases. They cause nicking of one strand of DNA to release tension.

DNA polymerase I : It is a major repair enzyme and it has 5′ ⟶ 3′ exonuclease activity.

DNA polymerase II : It is a minor repair enzyme.

DNA polymerase III : It is mainly involved in DNA replication by addition and polymerisation of new bases.

Primase : It helps in formation of RNA primer.

DNA ligase : Okazaki fragments are joined by DNA ligase.

16. When male produces two types of sperms and females produce only one type of eggs, it is termed as male heterogamety. Male heterogamety can be found in *Drosophila* and humans.

Differences between male and female heterogamety are as follows:

	Male heterogamety	Female heterogamety
(i)	Male produces two types of sperms, androsperms and gynosperms and females form only one type of ova.	Females form two types of ova and the males produce only one type of sperms.
(ii)	*E.g.*, XX–XY type in *Drosophila*.	*E.g.*, ZW–ZZ type in birds.

17. (a) Griffith grew bacteria on a culture plate, some produced smooth shiny colonies (S) while others produced rough colonies (R). Mice infected with the S strain (virulent) die from pneumonia infection but mice infected with the R strain do not develop pneumonia.

Griffith observed that heat-killed S strain bacteria, when injected into the mice, did not kill them.

When he injected a mixture of heat-killed S strain and live R bacteria, the mice died. Moreover, he recovered living S strain bacteria from the dead mice.

S strain ⟶ Injected into mice ⟶ Mice die

R strain ⟶ Injected into mice ⟶ Mice live

S strain (heat-killed) ⟶ Injected into mice ⟶ Mice live

S strain (heat - killed) + R strain (live) ⟶ Injected into mice ⟶ Mice die

From this experiment, Griffith concluded that the R strain bacteria had been transformed by the heat-killed S strain bacteria as some transforming element transferred from heat killed S strain enabled the R strain to become virulent.

(b) Three scientists who followed up Griffith's experiment are O.T. Avery, C. Macleod and M.McCarty.

18. (a) Given figure represents the adaptive radiation of Australian marsupials.

(b) These organisms are found in Australian island continent.

(c) This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation. A number of marsupials, each different from the other evolved from an ancestral stock, but all within the Australian island continent. When more than one adaptive radiation appeared to have occurred in an isolated geographical area, it is called convergent evolution.

OR

(a) Founder effect – When a small group of persons called founders, leave their homes to find a new settlement, the population in a new settlement may have different genotype frequencies from that of the parent population. Formation of a different genotype in new settlement is called the founder effect.

(b) Genetic drift – It refers to the elimination of certain traits when a section of a population migrates or dies in natural calamity. It alerts the gene frequency of remaining population which causes variation.

(c) Convergent evolution – Development of similar adaptive functional structures in unrelated groups of organisms is called adaptive convergence or convergent evolution. *E.g.*, wings of insect, bird and bat.

19. The four main propositions of Lamarck are :

(i) Internal vital force : All the living things and their component parts are continually increased due to internal vital force.

(ii) Effect of environment and new needs : Environment influences all types of organisms. A change in environment brings about changes in organisms. It gives rise to new needs. New needs or desires produce new structures and change habits of the organisms. Doctrine of desires is called appetency.

(iii) Use and disuse of organs : If an organ is constantly used it would be better developed whereas disuse of organ results in its degeneration.

(iv) Inheritance of acquired characters : Whatever characters an individual acquire in its life time due to vital force, influence of environment, use and disuse of organs, they are inherited to the next generation.

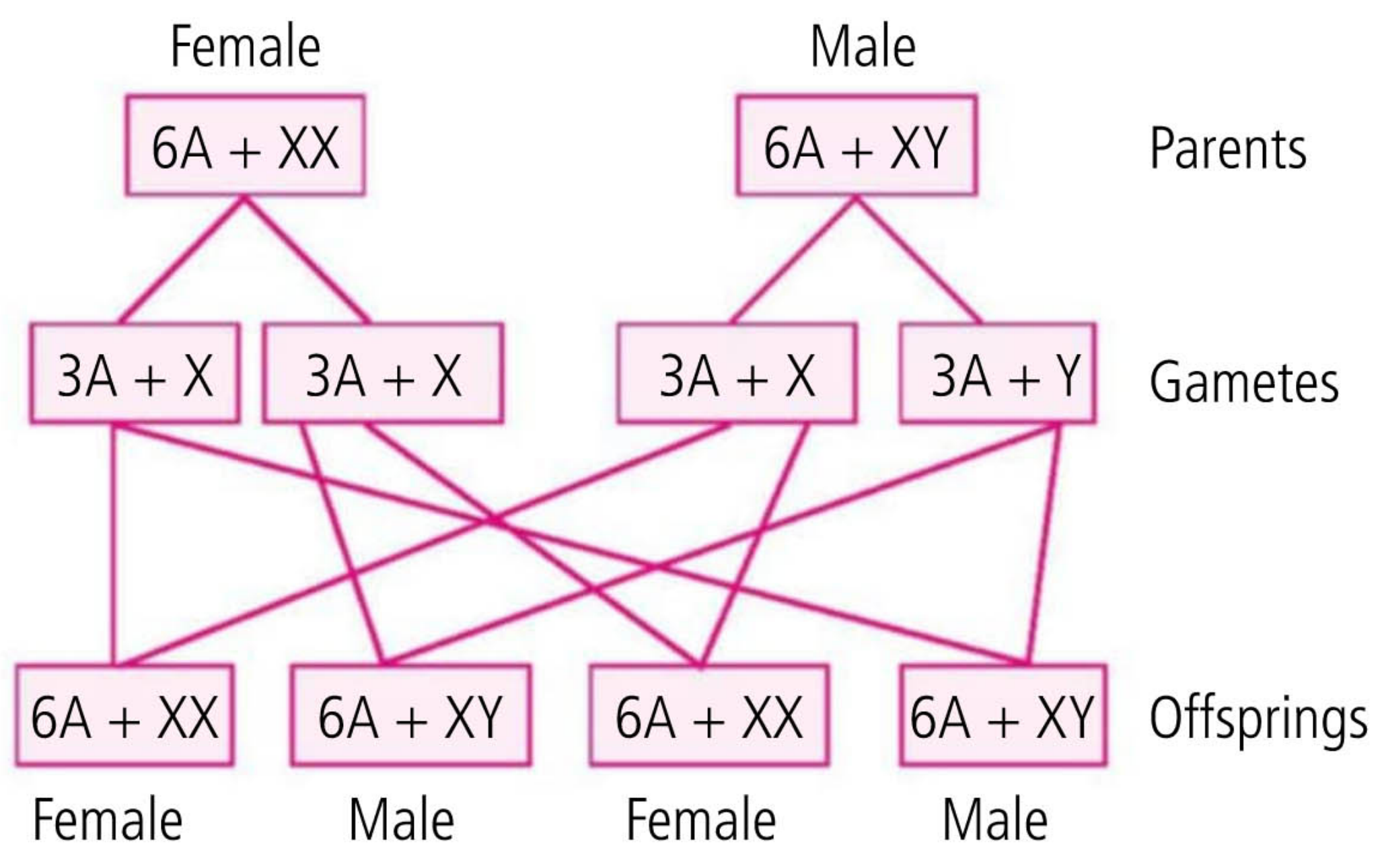
OR

Linkage is complete when genes located in the same chromosome do not separate and are inherited together over the generations due to the absence of crossing over. Complete linkage allows the combination of parental traits to be inherited as such.

Differences between complete linkage and incomplete linkage are:

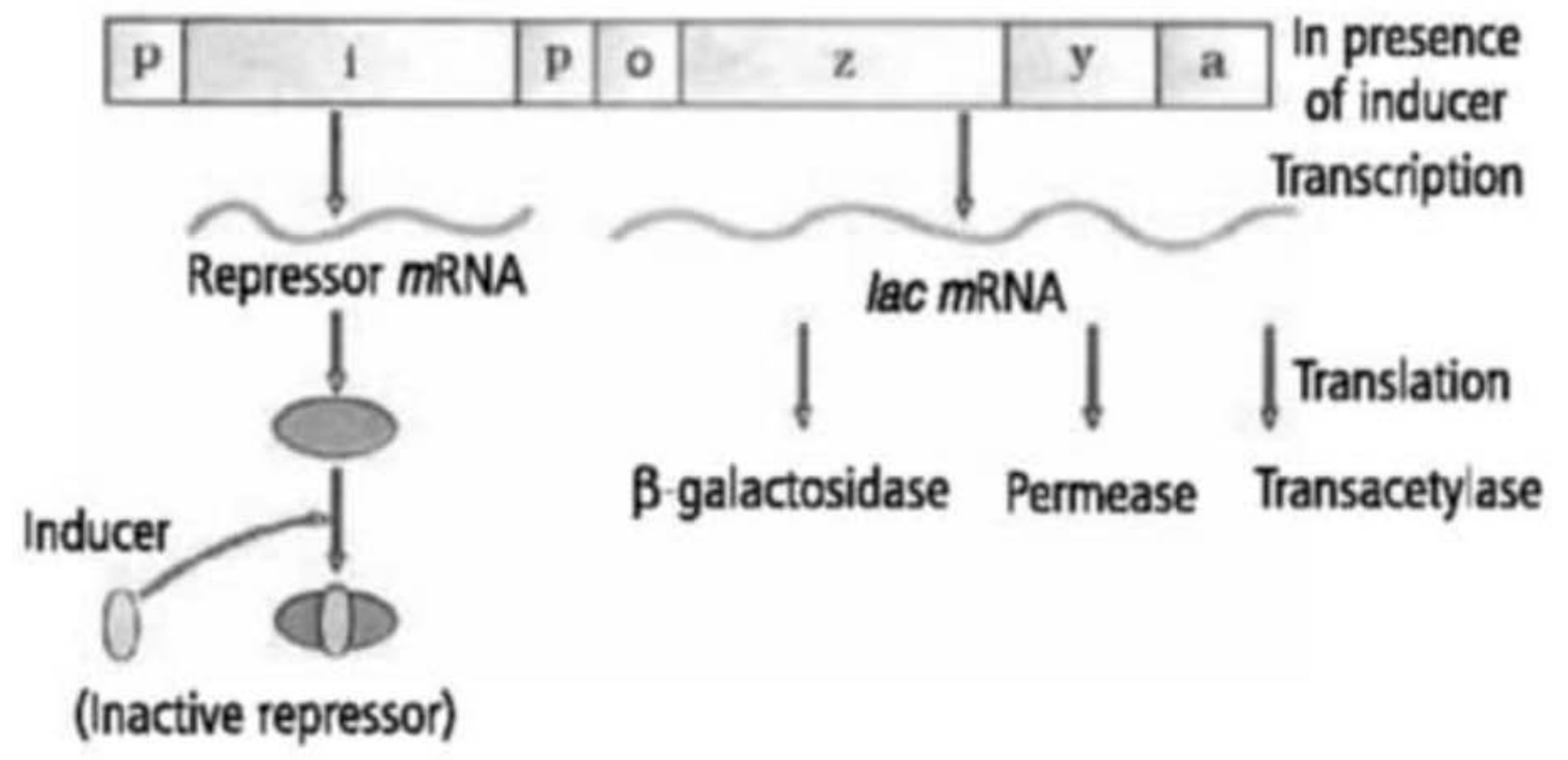
	Complete linkage	Incomplete linkage
(i)	The genes located very closely in the same chromosome remain linked and are inherited together over the generations without disturbing linkage groups.	The genes are present distinctly in the same chromosome and have a tendency to occasionally separate.
(ii)	There is no crossing over between closely linked genes.	Crossing over occurs to bring recombinants alongwith parental types.
(iii)	It is of rare occurrence and reported in organisms like male *Drosophila*, female silk worm.	It is quite common.
(iv)	It produces parental types and no recombinants in the progeny.	It produces more of parental types (>50%) alongwith few recombinants (<50%) in the progeny.

20. *Drosophila* has eight chromosomes (4 homologous pairs), in which six chromosomes (3 pairs) are autosomes, common to both males and females. The fourth pair is of sex chromosomes. The males are heterogametic, thus contains 6 autosomes + XY chromosomes. The females are homogametic and therefore, they have 6 autosomes + XX chromosome. Ova produced by the female are similar having 3 autosomes + X chromosomes, however, sperms produced by male are of two types— 3 autosomes + X chromosome and 3 autosomes + Y chromosome.



Female - 50%; Male - 50%

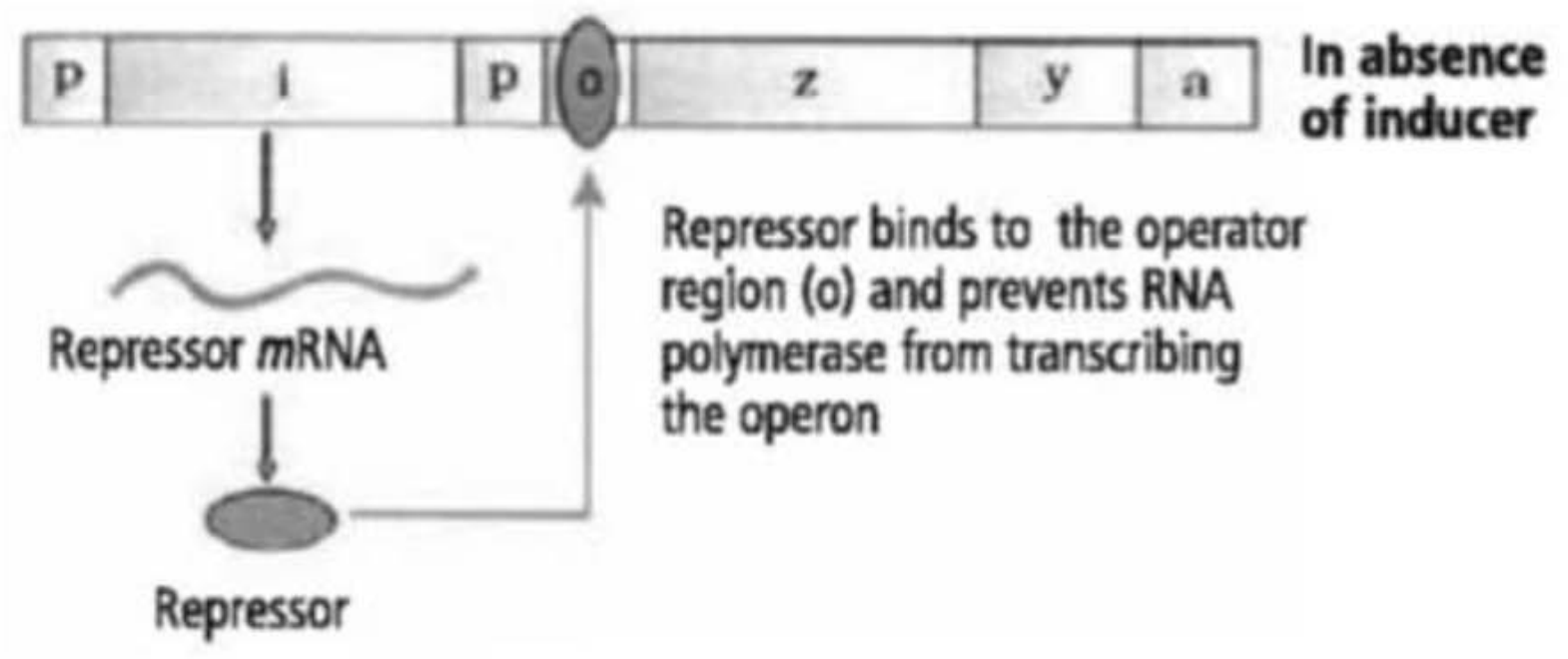
21. The illustration of *lac* operon in a switched on state is as follows:



An operon is a part of genetic material (or DNA) which acts as a single regulated unit having one or more structural genes, an operator gene, a promoter gene, a regulator gene, a repressor and an inducer or corepressor (from outside).

Lactose acts as an inducer in *lac* operon. The repressor molecule coded by *i* gene is inactivated by interaction with the lactose. This allows RNA polymerase to access the promoter and transcription proceeds. The operon gets switched 'off' in the absence of lactose as the repressor molecule binds with the operator region of the operon and prevents RNA polymerase from transcribing the *m*RNA.

Diagrammatic representation of switch off condition of *lac* operon is as follows:


p
i
p
o
z
y
a
In absence of inducer
Repressor binds to the operator region (o) and prevents RNA polymerase from transcribing the operon
Repressor mRNA
Repressor

22. **(i)** Genotype of I - 1 should be Aa, since the trait is present in father due to presence of two recessive genes (aa). The trait can appear in the progeny only when it becomes homozygous recessive. From the given pedigree, we can see that only one progeny is carrying the trait, therefore the mother must be heterozygous, *i.e.*, Aa.

(ii) Genotype of II-1 is aa.

(iii) Genotype of II - 2 is Aa.

OR

(a) Klinefelter's syndrome is a disorder caused due to an additional X-chromosome. The individual has 22 pairs of autosomes and XXY sex chromosomes, *i.e.*, the karyotype is 44 + XXY.

The diagnostic features of such individuals are:

(i) The male shows development of feminine characters like development of breasts, sparse body hair.

(ii) The individual is sterile.

(iii) Underdeveloped testes and mental retardation.

(b) It is caused by union of an abnormal XX egg and a normal Y sperm or normal X egg and abnormal XY sperm. The individual has 47 (44 + XXY) chromosomes.

23. Due to industrial smoke and soot the pale tree trunks became more and more blackened. As a result, the light moths stood out in contrast to its background, increasing the possibility of being easily detected and eaten by their predators, (such as birds), in much greater number than the dark melanic variety. Decrease in the number of light winged moths and increase in the number of dark variety was the ultimate result. Therefore, evolution favoured the dark winged melanic moths to reproduce more successfully for their adaptation in the polluted areas. Evolution of darker form in response to industrial pollution is known as industrial melanism.

24. The characteristics of *Ramapithecus* are:

(i) They were more man-like and perhaps walked erect on hind feet.

(ii) They lived on the tree tops but also walked on the ground.

(iii) Their jaws and teeth were like those of humans.

The characteristics of Neanderthal man are:

(i) They possess a brain capacity of 1400 c.c.

(ii) They walked upright and had low brows, receding jaws and high domed heads.

(iii) They used hides to protect their body and bury their dead.

25. Rahul can find out the genotype of plant by performing test cross. Test cross is used to identify whether an individual is homozygous or heterozygous for dominant character. The individual with unknown genotype is crossed with homozygous recessive parent for the trait being investigated.

Tall plant with violet coloured flower could have following possible genotypes : TTVV and TtVv.

Case I : Homozygous tall plant with violet colour flower is crossed with recessive parent.

Parents : TTVV (Tall violet) × ttvv (Dwarf white)

Gametes : TV TV tv tv

F_1 generation : TtVv - All Tall violet (Heterozygous)

If plant produce all tall plants with violet flowers as offspring, then genotype of plant is TTVV.

Case II: Tall plant with violet flower (heterozygous for both the traits) is crossed with recessive parent.

Parents : TtVv × ttvv

Gametes: TV tV Tv tv tv tv

	TV	tV	Tv	tv
tv	TtVv	ttVv	Ttvv	ttvv

Tall violet : Dwarf violet : Tall white : Dwarf white

1 : 1 : 1 : 1

If the given ratio is obtained, then the genotype of plant is TtVv.

OR

(a) Differences between homologous and analogous organs are :

	Homologous organs	Analogous organs
(i)	They differ morphologically.	They show superficial resemblance.
(ii)	They have similar internal structure.	Their internal structure is quite different.
(iii)	They develop in related organisms.	They develop in unrelated organisms.
(iv)	Stages in the development are similar.	Stages in the development are different.

Both homologous and analogous organs provide concrete evidence in support of evolution. Homology, (similarity between organs of different animals) indicates common ancestry, or common embryonic origin. Analogy shows that evolution of similar adaptive features in different groups of organisms is due to similar habitat.

(b) The theory of biogenesis given by Louis Pasteur, states that life originated from pre-existing life. Pasteur took broth in a long necked flask and bent its neck (swan neck). He boiled the broth in this flask to kill any microorganisms that might be present in it. This flask was kept for months but, no life appeared, as the germ laden dust particles in the air were trapped by the curved neck of the flask that served as filter. When the swan neck was broken off, the broth developed colonies of moulds and bacteria. Thus, he showed that the source of the microorganisms for fermentation or putrefaction was the air and the organisms did not arise from the nutrient media.

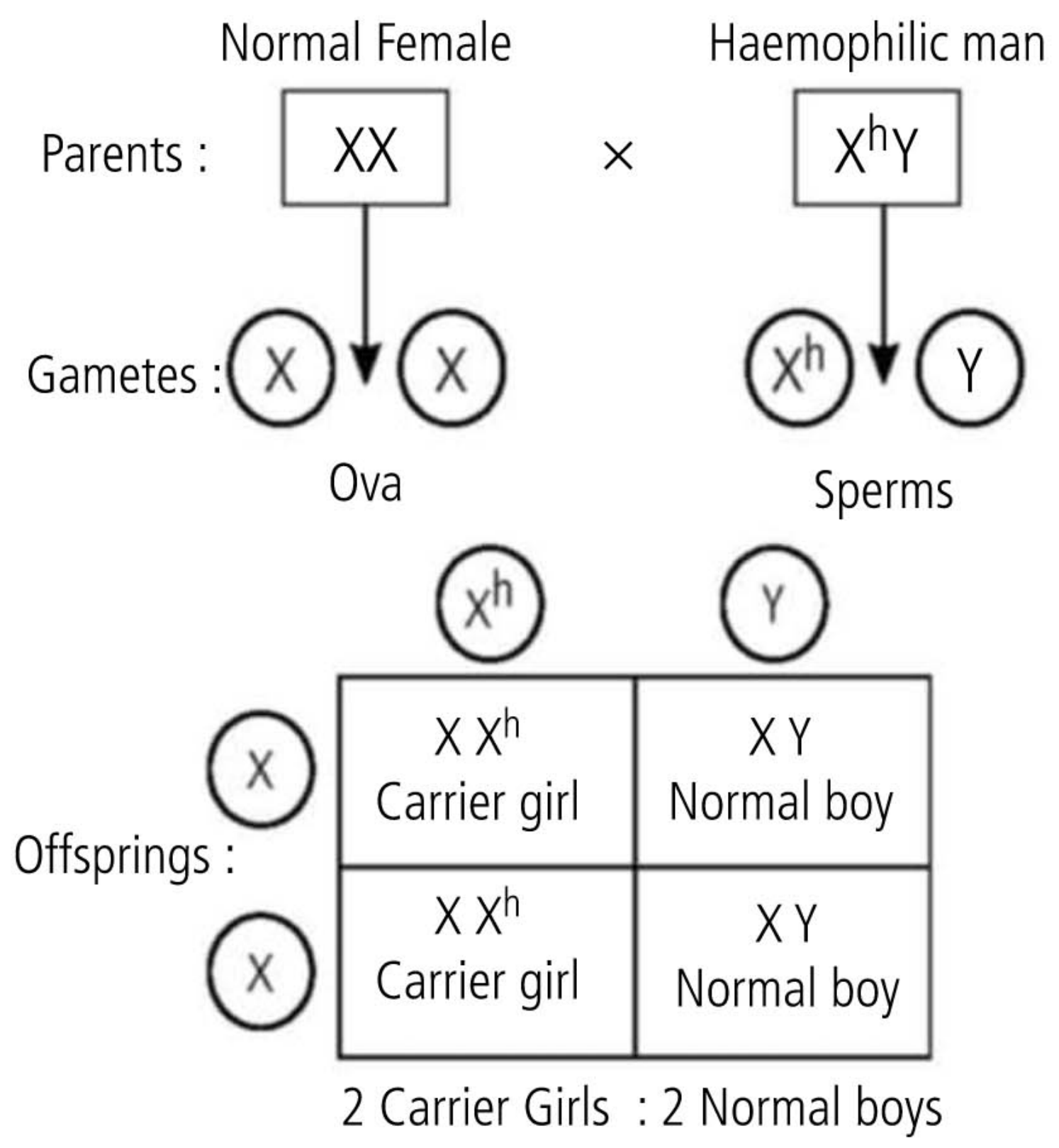
26. (a) The birds seen by Darwin were finches. Darwin's finches of the Galapagos Islands represent adaptive radiation. Adaptive radiation (divergent evolution) is the evolution from a common ancestral form to a number of different forms.

Darwin's finches had a common ancestor but they developed different types of modified beaks according to their food habits. As the original population of finches increased in size it spreaded out from its centre of origin to exploit new habitats and food sources. After some time it resulted in evolution of a number of populations, each adapted to its particular habitat. Eventually these populations differed from each other sufficiently to become new species. Darwin differentiated thirteen species of finches and grouped them into six main types–(i) Large ground finches (ii) Cactus ground finches feeding on cacti (iii) Vegetarian tree finches (iv) Insectivorous tree finches (v) Warbler finches (vi) Tool-using or woodpecker finches.

(b) A number of marsupials, each different from the other evolved from an ancestral stock, but all within the Australian island continent. The process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation. Adaptive radiation can be referred to as divergent evolution, when more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats).

OR

(a) A haemophilic (X^hY) man marries a normal women (XX) but the diseases does not appear in any of the immediate offspring because haemophilia bearing X-chromosome of father is directly transferred to daughter only. The daughters receive a normal X-chromosome from the mother and hence they become a carrier. The son receive Y chromosome from their father and normal X chromosome from their mother. So he will be normal.



(b) Symptoms of haemophilia: Clotting of blood is affected as one of the factors needed for clotting is not synthesised, so in a haemophilic individual, even a simple cut leads to non-stop bleeding.

27. In bacteria/prokaryotes, transcription occurs in contact with cytoplasm as their DNA lies in the cytoplasm. It has following steps:

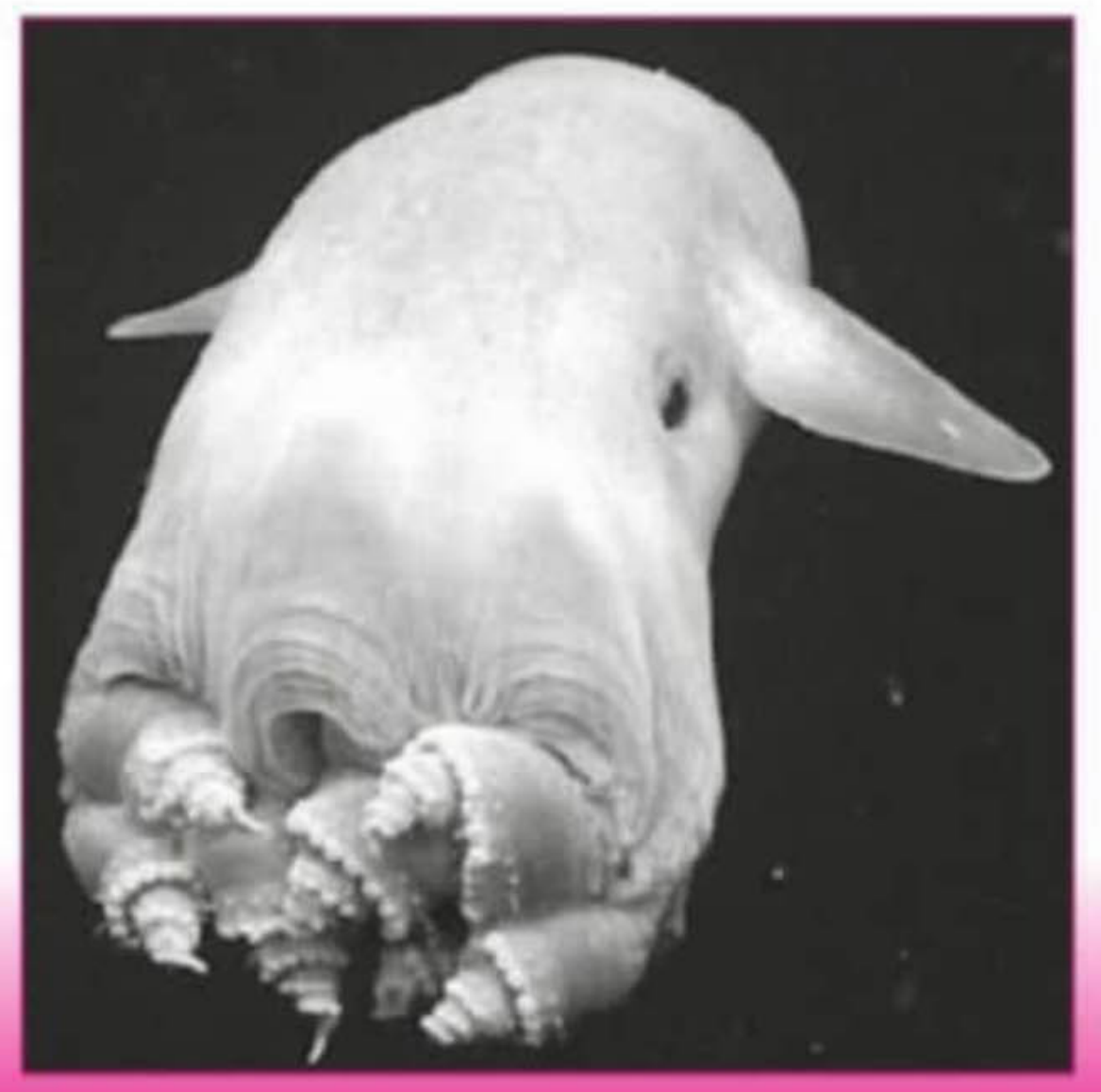
(i) Activation of ribonucleotides – The four types of ribonucleotides are adenosine monophosphate (AMP), guanosine monophosphate (GMP), uridine monophosphate (UMP) and cytidine monophosphate (CMP). They occur freely in the nucleoplasm. Prior to transcription the nucleotides are activated through phosphorylation. Enzyme phosphorylase is required alongwith energy. The activated or phosphorylated ribonucleotides are adenosine triphosphate (ATP), guanosine triphosphate (GTP), uridine triphosphate (UTP) and cytidine triphosphate (CTP).

(ii) Binding of RNA polymerase to DNA duplex – On a signal from the cytoplasm, DNA segment become ready to transcribe. The DNA dependent RNA polymerase enzyme binds to a specific site, called promoter, in the DNA double helix. Prokaryotes have only one RNA polymerase that synthesise

WHO AM I ...

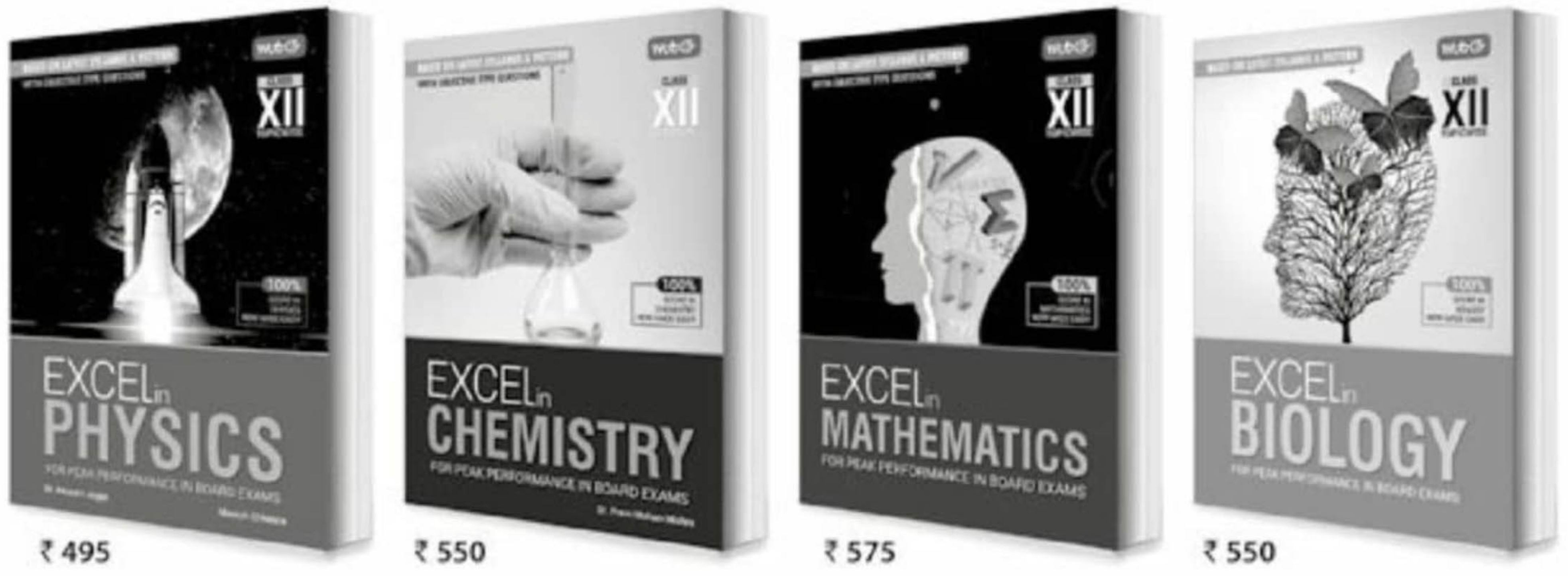
1.	Chitin	Pg. 12
2.	Interphase	Pg. 20
3.	Gene flow	Pg. 49
4.	Disruptive selection	Pg. 51

Whatz it?



Send your response at editor@mtg.in or post to us with complete address by 10th of every month. Winners' name will be published in next issue.

Concerned about your performance in Class XII Boards?



Well, fear no more, help is at hand.....

To excel, studying in right direction is more important than studying hard. Which is why we created the Excel Series. These books for Physics, Chemistry, Biology & Mathematics - have been put together totally keeping in mind the prescribed syllabus and the pattern of CBSE's Board examinations, so that students prepare and practice with just the right study material to excel in board exams.

Did you know nearly all questions in CBSE's 2019 Board Examination were a part of our Excel books? That too fully solved !

HIGHLIGHTS
- Comprehensive theory strictly based on NCERT, complemented with illustrations, activities and solutions of NCERT questions
- Topicwise Practice questions for Board Exams
- Topicwise Previous years' (2001-2019) CBSE Board Solved Papers
- Chapterwise Self assessment for better practice
- Model Test Papers as per latest CBSE Blue Print

Scan now with your smartphone or tablet*

Visit www.mtg.in for latest offers and to buy online!

MtG Learning Media

Available at all leading book shops throughout the country.
For more information or for help in placing your order:
Call 0124-6601200 or email: info@mtg.in
*Application to read QR codes required

---

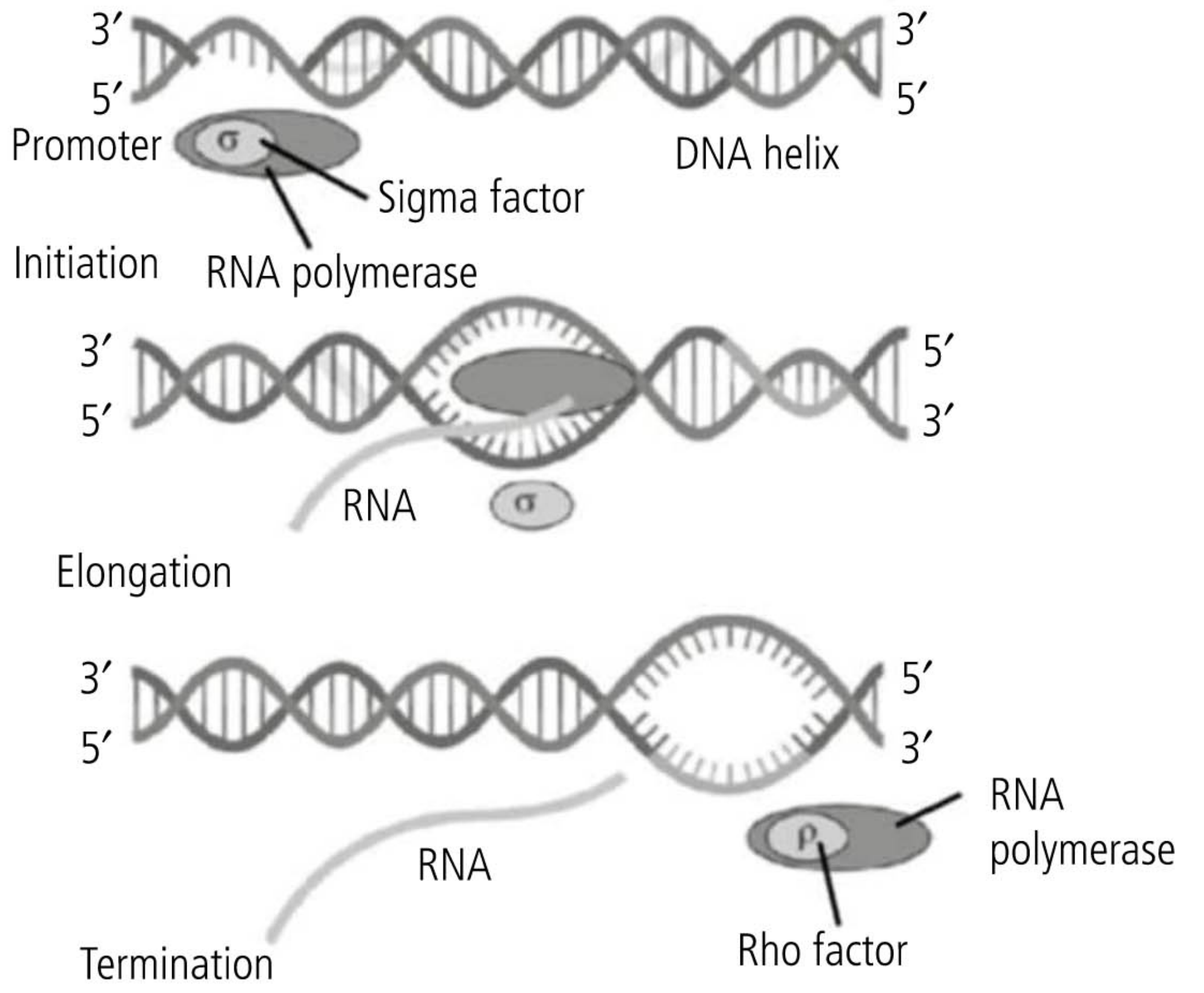
all types of RNA. The promoter also determines which DNA strand is to be transcribed. Thus, a promotor region has RNA polymerase recognition site and RNA polymerase binding site. Chain opening occurs in the region called TATA box.

(ii) Base pairing – Ribonucleoside triphosphates present in the surrounding medium come to lie opposite the nitrogen bases of the DNA template (anti-sense strand). They form complementary pairs; U opposite A, A opposite T, C opposite G and G opposite C. A pyrophosphate is released from each ribonucleoside triphosphate to produce ribonucleotide.

(iv) Formation of RNA chain – With the help of RNA polymerase the adjacent ribonucleotides held over DNA template join to form RNA chain. A single RNA polymerase recognise promoter and initiation region in prokaryotes. As the RNA chain formation initiates, the sigma (σ) factor of the RNA polymerase separates. RNA polymerase (core enzyme) moves along the DNA template causing elongation of RNA chain at the rate of some 30 nucleotides per second. RNA synthesis stops as soon as polymerase reaches the terminator region. Rho factor (ρ) is required for this.

(v) Separation of RNA chain – With the help of rho factor, the fully formed RNA chain is now released. One gene forms several molecules of RNA, which are released from the DNA template one after the other on completion. The released RNA is called primary transcript.

(vi) Duplex formation – As the RNA chain is released, the two strands of DNA establish linkages and the two are spirally coiled to assume the original double helical form. The protective protein coat is added again to the DNA duplex. Gyrases, helicases and helix stabilising proteins are released.



OR

(a) Initiation and termination of translation process in prokaryotes are as follows:

Initiation : When the small subunit of ribosome encounters the *m*RNA, translation begins. The *m*RNA binds to the smaller subunit of ribosome catalysed by initiation factors. There are two sites on the larger subunit of ribosome, the P-site and the A-site. The smaller subunit attaches to the larger subunit in such a way that the initiation codon (AUG) comes on the P-site. The initiator *t*RNA (methionine-*t*RNA) binds to the P-site.

Termination : The synthesis of polypeptide chain is terminated when stop/terminator codons UAA, UAG or UGA comes at the A-site of ribosome. These codons do not code for any amino acid.

Guanosine triphosphate (GTP) dependent release factors cleaves the polypeptide chain from the terminal *t*RNA, releasing the polypeptide from the ribosome.

(b) In eukaryotes, the primary transcript which is often larger than the functional RNA is called heterogeneous nuclear RNA or hnRNA. Post-transcription processing is required to convert primary transcript of all types of RNAs into functional RNAs. It is of four types.

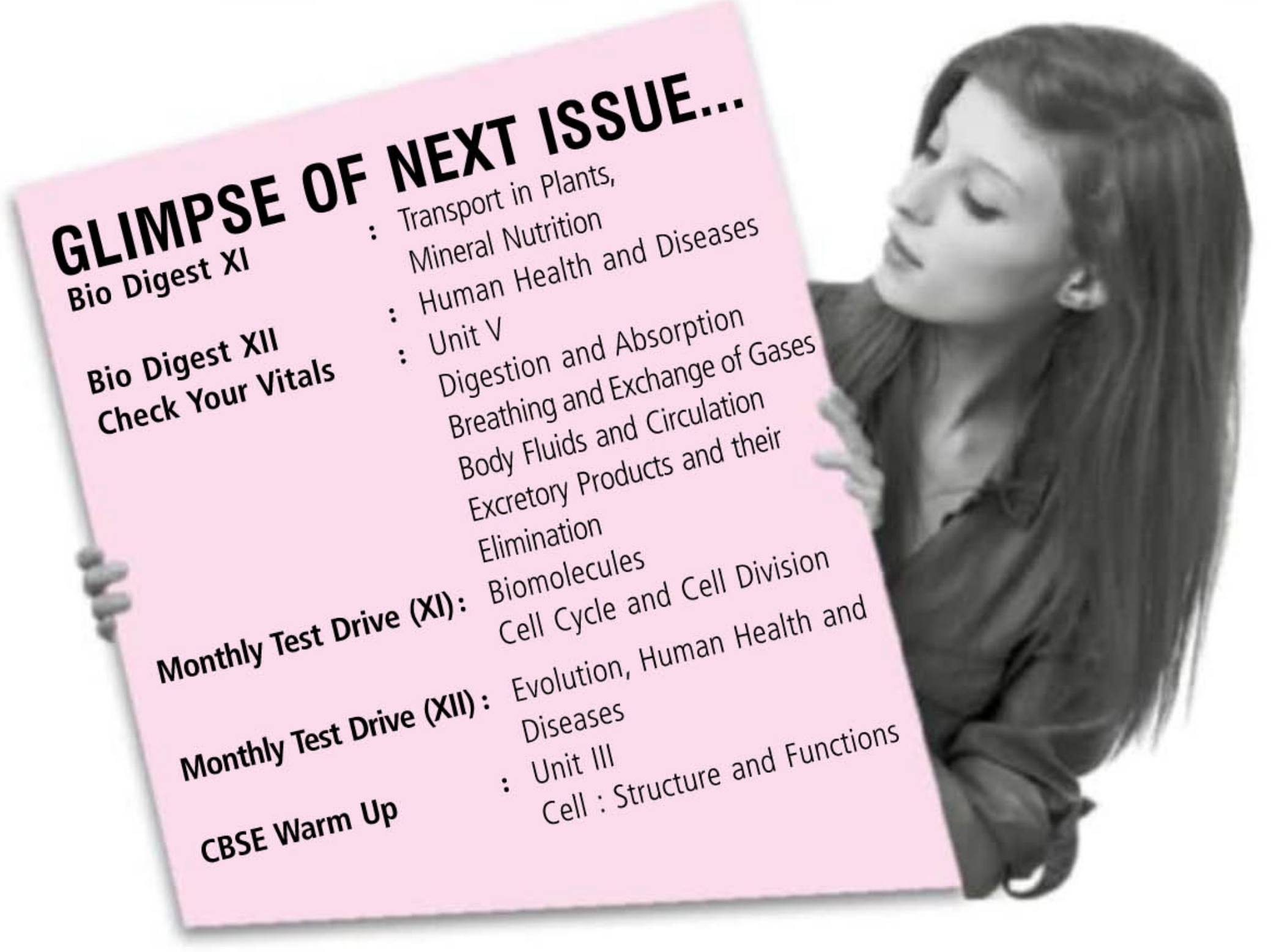
(i) Cleavage : Larger RNA precursors are cleaved to form smaller RNAs.

(ii) Splicing : Eukaryotic transcripts possess extra segments called introns or intervening sequences or noncoding sequences. They do not appear in mature or processed RNA. The functional coding sequences are called exons. Splicing is removal of introns and fusion of exons to form functional RNAs.

(iii) Terminal additions (capping and tailing) : Additional nucleotides are added to the ends of RNAs for specific functions, *e.g.*, CCA segment in *t*RNA, cap nucleotides at 5′ end of *m*RNA or poly-A segments (200-300 residues) at 3′ end of *m*RNA. Cap is formed by modification of GTP into 7-methyl guanosine or 7 mG.

(iv) Nucleotide modifications :They are most common in *t*RNA-methylation (*e.g.*, methyl cytosine, methyl guanosine), deamination (*e.g.*, inosine from adenine), dihydrouracil, pseudouracil, etc.

☺☺



GLIMPSE OF NEXT ISSUE...

Bio Digest XI : Transport in Plants, Mineral Nutrition
Bio Digest XII : Human Health and Diseases
Check Your Vitals : Unit V
Digestion and Absorption
Breathing and Exchange of Gases
Body Fluids and Circulation
Excretory Products and their Elimination
Monthly Test Drive (XI) : Biomolecules
Cell Cycle and Cell Division
Monthly Test Drive (XII) : Evolution, Human Health and Diseases
CBSE Warm Up : Unit III
Cell : Structure and Functions

FIELD NOTE

Snow Leopard

Scientific Name : *Panthera uncia*

Population : 450-500 (India)

IUCN Red List Status : Vulnerable

Nest

Snow leopards live in the mountainous regions of Central and Southern Asia. In India, their geographical range encompasses a large part of the Western Himalayas including the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh in the Eastern Himalayas. It inhabits alpine and sub-alpine zones at elevations from 3,000 to 5,000 m (9,800 to 14,800 ft).

Features

Snow leopards are standing about 24 inches at the shoulder, length wise 90-130 cm and weighing around 30-55 kgs. Covered with fascinating smoky-grey fur patterned with dark-grey to black that help them to disguise in rocky slopes. These are most active in dawn and dusk. Like most species of cats, snow leopards are also solitary animals. Male and female species might be seen together during mating season. Snow leopards have powerful legs and are tremendous leapers, able to jump as far as 50 feet. They use their long tails for balance and as blankets to cover sensitive body parts against the severe mountain chill.

Diet

The snow leopard is a carnivore and actively hunts its prey. Its preferred wild prey species are Himalayan blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), argali (*Ovis ammon*), markhor (*Capra falconeri*) and wild goat (*Capra aegagrus*).

INTERESTING FACTS

- Snow leopards do not roar, instead, they growl, yowl, mew and prusten (also called chuffing, a non-threatening vocalisation made by blowing air through their nose).
- They are often called the "ghosts of the mountain" because they are so rarely seen and spend most of their lives in solitude.
- The fur on their stomachs is nearly five inches thick to help them survive in cold, harsh mountain climates.
- They can prey on animals up to three times their own body weight.

Mating time

January to March. During mating time, both sexes mark their territories with signs of faeces, scrapes, urine and scent-spray along their travel routes.

Threats

Climate change is one of the major causes which can make these most elusive big cats close to extinction. Other threats such as poaching, retaliatory killings by herders, declining prey species etc. also contribute huge threat to these incredible animals. These cats appear to be in dramatic decline because of such killings, and due to poaching driven by illegal trades in pelts (skin with fur) and in body parts used for traditional Chinese medicine.

Protection

Snow leopards are protected by different national laws in their range countries. The Government of India has identified the snow leopard as a flagship species for the high-altitude Himalayas. Leopards are protected under India's wildlife protection Act of 1972. This law doesn't seem to stop poachers, but it does give authorities the ability to arrest and prosecute.

Please send your feedback for our new article by mail at editor@mtg.in

---

YOU ASK WE ANSWER

Do you have a question that you just can not get answered? Use the vast expertise of our MTG editorial team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough. Few questions and their solutions are printed in this column.

Readers can send their queries at editor@mtg.in or post to us.

Q.1. How does Ebola virus neutralises our immune system? Is there any way to cure it after being affected? *– Soumyadip*

Ans. Ebola viruses are negative-stranded RNA viruses in the Family Filoviridae and are endemic to regions of west and equatorial Africa. Once the virus enters the body, it targets several types of immune cells. It infects dendritic cells, which normally display signals of an infection on their surfaces to activate T lymphocytes—the white blood cells that could destroy other infected cells before the virus replicates further. With defective dendritic cells failing to give the right signal, the T cells don't respond to infection, and neither do the antibodies that depend on them for activation. The virus, can starts replicating here immediately and very quickly. This virus also inhibits interferon—a type of molecule that cells use to hinder further viral reproduction. In a new study, researchers found that one of the Ebola's protein, VP24, binds and blocks a transport protein on the surface of immune cells that plays an important role in the interferon pathway. The lymphocytes themselves don't become infected with the virus, but a series of other factors—a lack of stimulation from some cells and toxic signals from others—prevent these primary immune cells from putting up a fight. In this way, the Ebola virus neutralises our immune system.

Recovery from Ebola virus disease (EVD) depends on good supportive care and the patient's immune response. Those who do recover develop antibodies that can last 10 years, possibly longer. It is not known if people who recover are immune for life or if they can later become infected with a different species of Ebola virus. To date, there is no Food and Drugs Administration (FDA) approved antiviral therapy or vaccine available for Ebola though researchers are working on it and treatment is limited to supportive care.

Q.2. What is there in Y chromosome which turns sex towards maleness? *– Sagar Mohanta, Odisha*

Ans. : The Sex-determining Region Y (*SRY*) gene is found on Y chromosomes that leads to the development of male phenotypes, such as testes. The *SRY* gene, located on the short branch of the Y chromosome, initiates male embryonic development in the XY sex determination system. The sex-determining gene *SRY* produces a protein also called, testis-determining factor (TDF) which initiates male development in humans, placental mammals and marsupials and prevent the development of female reproductive structures (uterus and fallopian tubes). TDF promotes the development of a testis in which the primitive sex cords proliferate and penetrate into the medulla to form the testicular cords. Some of those cells differentiate into Sertoli cells, whilst the remainings become incorporated into seminiferous tubules. The testis-determining factor also induces differentiation of gonadal mesenchymal cells into the interstitial Leydig cells.

Q.3. What is paratonic and autonomic movements of growth in plants? *– Sunil*

Ans. The movements due to external factors or stimuli like light, temperature and chemicals are called paratonic growth or movement of locomotion in plants. This movement is induced by some unidirectional external stimuli. Their direction is controlled by the direction of the stimulus. Depending upon the type of stimulus, these movements are of three types: (i) Phototactic movement-these movements occur

Your favourite MTG Books/Magazines available in
DELHI at

Satija Book Depot - "Shop No. 4, 21st Century Plaza,Community Centre Sector-8, Rohini, New Delhi Delhi Pin-110085" Ph: 27941152; 9868049598
Lov Dev & Sons - "92B Opp. Hindi Park, Daryaganj, New Delhi, Delhi Pin-110002" Ph: 43215656, 43215650; 9811182352
Mittal Books - Daryaganj Ph: 011-23288887; 9899037390
Janta Book Depot Pvt Ltd. - Gole Market Ph: 23362985, 23369685; 9350257596
Mittal Book Distributors - Daryaganj Ph: 9811468898, 9810565956
Bokaro Students Friend Pvt Ltd - Daryaganj Ph: 9234636010
Ms Enterprises - Vikas Puri Ph: 9810257310
Yours Books & Stationers - Dwarka Ph: 9810676100
Naval Book Depot - R.K. Puram Ph: 011-26175789, 26102425
Raaj Book Point - Karkardooma Ph: 011-22371098, 22375017; 9811021981
Budaniya Book Shop - Uttam Nagar East Ph: 22759059; 9958129735
Anand Book Corner - Mayur Vihar Ph: 22751946, 47; 9868102255, 9868082201
New Arihant Book Depot - Kalu Sarai Ph: 26524221, 65726582; 9811522520
Schoolkart Technologies Pvt. Ltd. - Patparganj Ph: 8800654410
Budaniya Book Shop - Prashant Vihar Ph: 47631039; 9910749282, 9212519280
Kashyap Brothers - Nai Sadak Ph: 65196167; 9811744071/ 9212144072
Lamba Book Depot - Tilak Nagar Ph: 9810156674, 7503222162, 9210575859
Raj Book Agency - Dwarka Ph: 64534374; 9811234161
Janta The Bookshop - Defence Colony Ph: 24604413; 9311167890
Mishra Book Depot - Kalu Sarai, New Delhi Ph: 26864637; 9313799595, 9818779375

Visit **"MTG IN YOUR CITY"** on www.mtg.in to locate nearest book seller OR write to **info@mtg.in** OR call **0124-6601200** for further assistance.

in response to the external stimulus, light, *e.g.*, zoospores in *Chlamydomonas*. (ii) Chemotactic movement- these movements occur in response to external chemical stimulus, *e.g.*, antherozoids in bryophytes and pteridophytes. (iii) Thermotactic movement-these movements occur in response to external temperature stimulus, *e.g.*, *Chlamydomonas* moves from cold water to medium warm water and from hot water to medium temperature water.

Autonomic movements of locomotion are due to internal stimuli. These movements are spontaneous. They arise automatically due to internal causes, especially due to genes. Autonomic movements can be seen clearly in unicellular organisms. Flagellar movement in *Chlamydomonas* is an autonomic movement. Other examples of autonomic movements are, beating of cilia and flagella, protoplasmic streaming etc.

Q.4. Why are birds that nest in trees are not affected by carbon dioxide produced by the same trees at night? *– Sagar Mohanta, Odisha*

Ans. : The amount of CO_2 exhaled by trees and all green plants is quickly diluted due to the air circulation and thus the CO_2 produced is diluted as quickly as it is expired by a plant. So, no animals are suffocated under any circumstances outside. Also at night, due to open environment, the percentage of CO_2 does not rise quite reasonably. Normally 0.03% CO_2 is in air and 21.7 % oxygen is in air. So even if CO_2 rises slightly, there is a lot of air in the open sky with which it will get mixed. Hence it will not affect birds nor any other animals.

Q.5. A fetus is a foreign tissue for a mother, but why doesn't a mother's body generate an immune response against it? What happens about the matter in case of surrogacy? *– Oyindrila Samanta, Vadodara*

Ans. During pregnancy a specialised endometrial stromal tissue, maternal decidua, is formed in response to the implanting embryo which ultimately forms a shell around the developing fetus and placenta. The decidual tissue impairs the overall function of dendritic cells. These cells are the most potent antigen presenting cells in the body and are critical for initiating T cell-mediated immune responses within lymph nodes. The onset of pregnancy also causes the genes that are responsible for recruiting immune cells to sites of inflammation to be turned off within the decidua. As a result of these changes, T cells are not able to accumulate inside the decidua and therefore do not attack the fetus and placenta. Also the placenta which is surrounded by dense, many-layered envelope provide protection to the developing fetus by preventing the passage of maternal cells and it also actively absorbs , removes and inactivates circulating antigens. The placental trophoblast cells do not express the classical MHC (Major Histocompatibility Complex) class I isotypes HLA-A and HLA-B, unlike most other cells in the body, and this absence is assumed to prevent destruction by maternal cytotoxic T cells, which otherwise would recognise the fetal HLA-A and HLA-B molecules as foreign.

In case of surrogacy, same mechanism is shown by the mother's body as soon as fetus gets implanted. ☺☺

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. ADNIMELB	(a) Caused by non-disjunction in meiosis (2n-2).
2. NRTANSTOFCEI	(b) Premature production of a flowering stem.
3. NRRYPPOHI	(c) An anticoagulant.
4. SVADOALIIONT	(d) Introduction of a gene in a eukaryotic cell without the help of any vector.
5. LHTASASMEAI	(e) The only movable cranial bone.
6. GINLTOB	(f) It's presence provides brown or clay colour to earthworm.
7. SNUOLMLYI	(g) Relaxation of arterial smooth muscle cells.
8. NHRIAEP	(h) A genetic disorder characterised by abnormal haemoglobin production.
9. DSIUAODHEPL	(i) A period of suspended development.
10. EDISAAUP	(j) The filaments of a flower united into two groups.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names will be published in next issue.

WORD GRID

Readers are requested to send their responses of word grid to be the winner.

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

Clues

1. A store house of dried, pressed and preserved plants on sheets.
2. An organism without cell wall and is the smallest of all living cells.
3. A structure found at the base of many algae and helps in anchorage to the substratum in water.
4. Fluid filled body cavity lined by mesoderm.
5. Stiff movable bristle like structure that help anchor and control the worm when moving through soil.
6. The central strand of a cilium or flagellum that is composed of array of microtubule.
7. The sugary fluid that is found in the phloem tissue of plants.
8. The first natural cytokinin, obtained from unripe maize grains.
9. A group of four chromatids at meiosis.
10. Plant pigment responsible for an orange, red and yellow colour mainly in fruits and vegetables.
11. Cells present in intestinal epithelium that secrete mucus.
12. Multicellular fleshy buds of *Agave* that take part in vegetative propagation.
13. A smallest segment of DNA that participates in recombination through crossing over.
14. A group of enzymes that catalyses the breakdown of sugar in the alcoholic fermentation.
15. A mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.
16. A mass of thin walled cells developed in tissue culture.
17. Branch of medicine dealing with the study of human blood.
18. Two thin walled blood receiving chambers of heart.
19. Malformation of bones due to excess of growth hormone produced by pituitary gland in adults.
20. The outermost layers of cells of the ovules that surrounds the female gametophyte and give rise to seed coat.

C	C	H	E	R	B	A	R	I	U	M	U	L	E	S
O	A	O	D	C	O	R	E	N	R	Y	H	Y	N	A
R	R	L	E	S	A	P	N	T	E	C	A	L	Y	X
K	O	D	M	L	X	L	A	E	M	O	E	N	D	S
M	T	F	A	T	O	U	L	G	I	P	M	A	E	X
Z	E	A	T	I	N	M	C	U	A	L	A	C	S	O
N	N	S	U	R	E	U	A	M	S	A	T	R	I	A
O	E	T	E	A	M	L	L	E	N	S	O	O	C	B
T	T	O	R	T	E	E	C	N	O	M	L	M	C	U
O	O	B	E	E	A	N	U	T	R	A	O	E	A	L
C	A	P	C	T	T	E	L	S	K	O	G	G	T	B
H	D	E	O	R	E	N	I	N	B	U	Y	A	I	I
O	M	A	N	A	O	G	O	B	L	E	T	L	O	L
R	A	P	I	D	P	Z	Y	M	A	S	E	Y	N	S
D	A	R	A	D	I	C	A	L	C	A	U	L	I	N

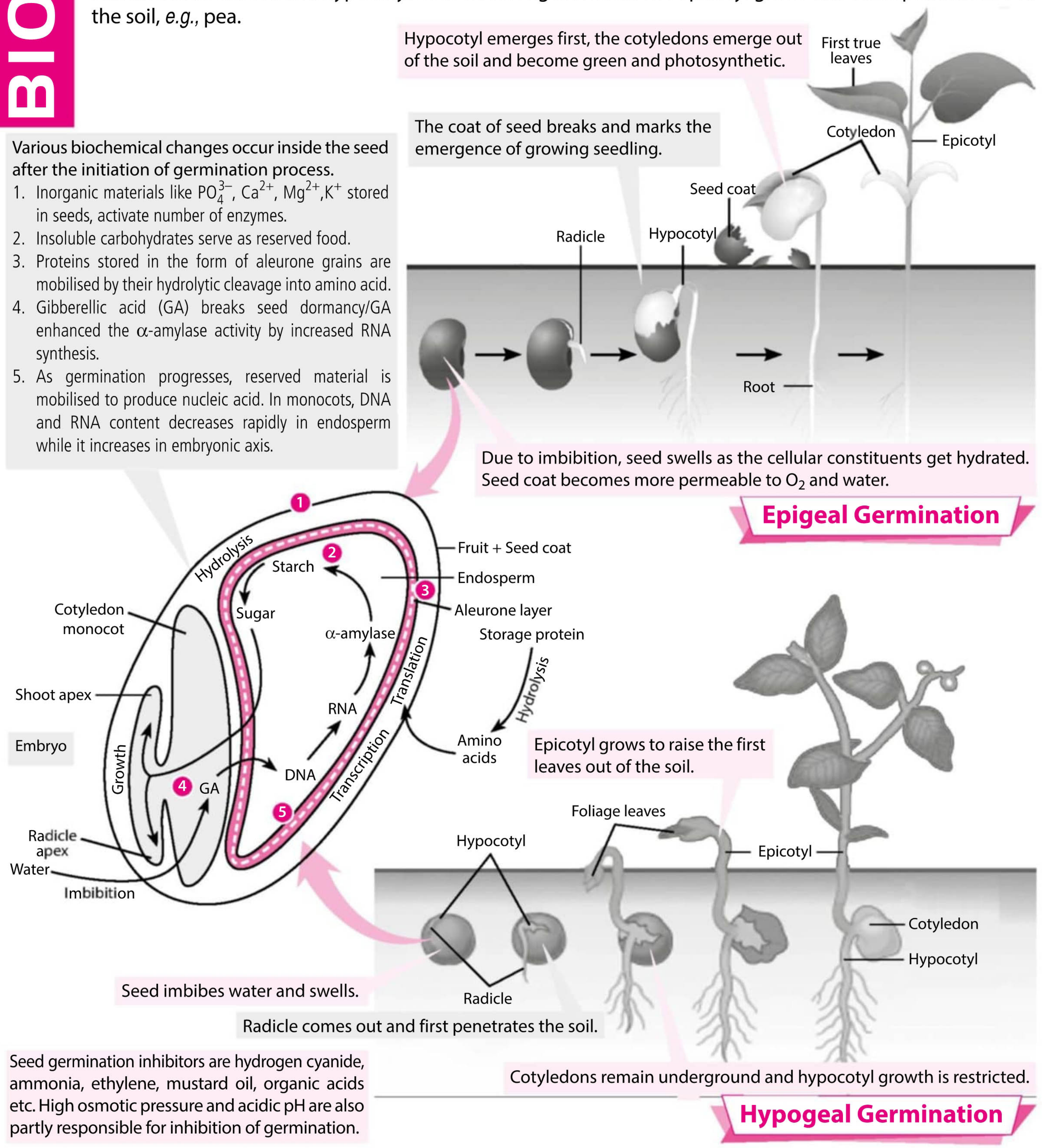
*Please send entries of solutions both with words and scanned copy of the grid.

Monthly Test Drive-4 CLASS XII ANSWER KEY

1. (d)	2. (a)	3. (b)	4. (c)	5. (a)
6. (a)	7. (a)	8. (d)	9. (a)	10. (b)
11. (b)	12. (c)	13. (c)	14. (d)	15. (a)
16. (b)	17. (b)	18. (c)	19. (a)	20. (d)
21. (d)	22. (a)	23. (b)	24. (b)	25. (c)
26. (b)	27. (a)	28. (c)	29. (a)	30. (b)
31. (d)	32. (a)	33. (b)	34. (c)	35. (c)
36. (a)	37. (d)	38. (d)	39. (d)	40. (a)

Seed Germination

Seed germination is a complex physiological phenomenon that begins with hydration of the seed and culminate in emergence of the embryonic axis (usually radicle) from the seed coat. A seed requires some crucial prerequisite such as water, oxygen, optimum temperature and sunlight (required by some seeds) to germinate into seedling. Seed germination is categorised into epigeal and hypogeal germination. In epigeal germination, the cotyledons come out of soil by the excessive growth of hypocotyl, become green and function as the first leaves of the seedling, *e.g.* castor, whereas in hypogeal germination, the cotyledons remain inside the soil and hypocotyl does not elongate much. The epicotyl grows and takes plumule above the soil, *e.g.*, pea.



Hypocotyl emerges first, the cotyledons emerge out of the soil and become green and photosynthetic.

The coat of seed breaks and marks the emergence of growing seedling.

Various biochemical changes occur inside the seed after the initiation of germination process.

1. Inorganic materials like PO_4^{3-}, Ca^{2+}, Mg^{2+},K^+ stored in seeds, activate number of enzymes.
2. Insoluble carbohydrates serve as reserved food.
3. Proteins stored in the form of aleurone grains are mobilised by their hydrolytic cleavage into amino acid.
4. Gibberellic acid (GA) breaks seed dormancy/GA enhanced the α-amylase activity by increased RNA synthesis.
5. As germination progresses, reserved material is mobilised to produce nucleic acid. In monocots, DNA and RNA content decreases rapidly in endosperm while it increases in embryonic axis.

Due to imbibition, seed swells as the cellular constituents get hydrated. Seed coat becomes more permeable to O_2 and water.

Epigeal Germination

Epicotyl grows to raise the first leaves out of the soil.

Seed imbibes water and swells.

Radicle comes out and first penetrates the soil.

Seed germination inhibitors are hydrogen cyanide, ammonia, ethylene, mustard oil, organic acids etc. High osmotic pressure and acidic pH are also partly responsible for inhibition of germination.

Cotyledons remain underground and hypocotyl growth is restricted.

Hypogeal Germination

BIO REPORTER

TURTLE EMBRYOS IN DETERMINING OWN SEX

In certain turtle species, the temperature of the egg determines whether the offspring will be female or male. These oviparous reptiles with temperature-dependent sex determination (TSD) are now at a risk of global warming threats. In a recent study, scientists have found that the embryos of the Chinese pond turtle (*Mauremys reevesii*) can change the temperature that influences their sexual destiny by moving around the egg. They have already demonstrated that the embryos could move around within their egg for thermoregulation. They carried out another experiment to know whether thermoregulation behavioural affect the sex determination in turtle. During the study, turtle eggs were incubated under a range of temperatures. It was found that a single embryo could experience a temperature gradient of up to 4.7°C within its egg while any shift larger than 2°C can massively change the offspring sex ratio of many turtle species. In half of the eggs, capsazepine, a chemical that blocked temperature sensors, was applied to prevent behavioural thermoregulation. After the eggs were hatched, the researchers found that the embryos without behavioural thermoregulation had developed as either almost all males or almost all females, as per the incubation temperatures. On the other hand, embryos that were able to react to temperatures by moving around inside their eggs; about half of them developed as males and the other half as females. This study suggests, the thermoregulation ability of a turtle embryo could help some species to maintain sex ratio balances. But then again, it can be said that, the embryo's control over its own sex may not be enough to protect it from the much more rapid climate change currently being caused by human activities.

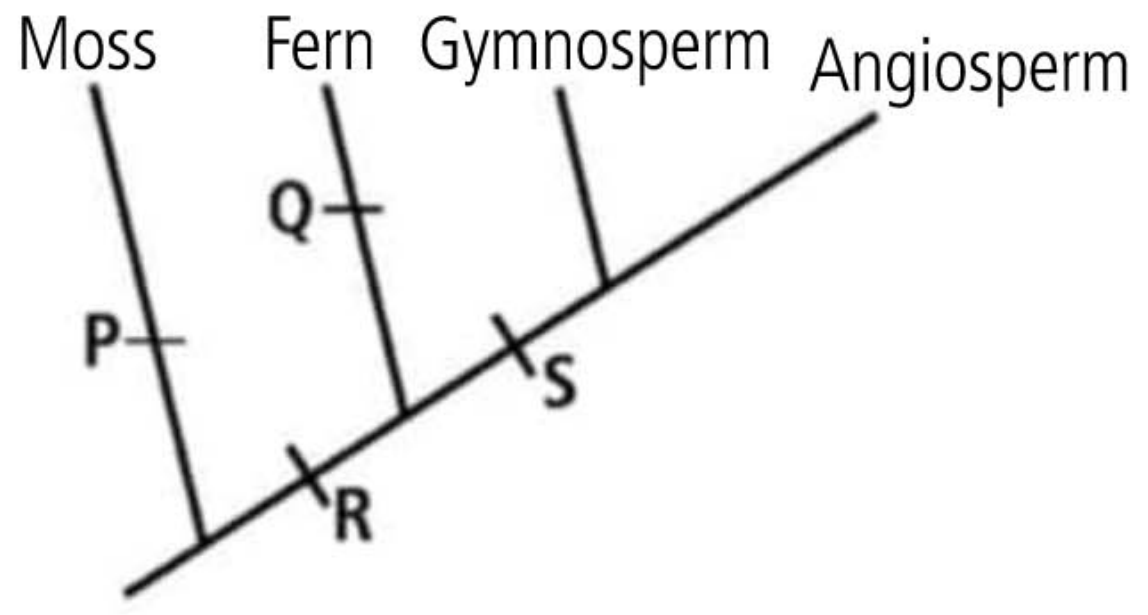
HORIZONTAL GENE TRANSFER NOW IN PARASITIC PLANTS

Horizontal gene transfer (HGT) is a common feature in microbial world. Interestingly, it has recently been found that functional HGT (fHGT) is increasingly being recognised in heterotrophic parasitic plants that obtain their nutrients and water from their host plants through direct haustorial feeding. A study was conducted on holoparasitic stem parasite *Cuscuta* sp. to assess fHGTs. The research team identified 108 genes that have been added to genome of *Cuscuta* by horizontal gene transfer from related species and now seem to be functional in the parasite, contributing to haustoria structure, defense responses, and amino acid metabolism. They also identified 42 additional regions with host-derived transposon, pseudogene and non-coding sequences. The team also explored the evolution of these transferred genes as additional support for functionality. The scientists are currently investigating the exact process by which genetic material is being transferred from host to parasite. They would also focus, whether this transfer is one-way, or if the host can also obtain the genetic material from its parasite.

BIOLOGY
OLYMPIAD PROBLEMS

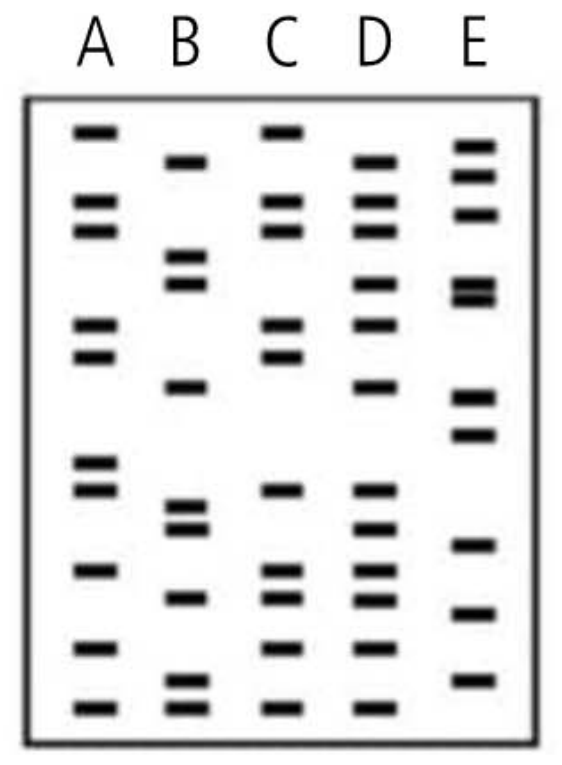
INBO

1. The 'free living and independent sporophyte as well as gametophyte' is a character that best fits at:



(a) P (b) Q (c) R (d) S *(2019)*

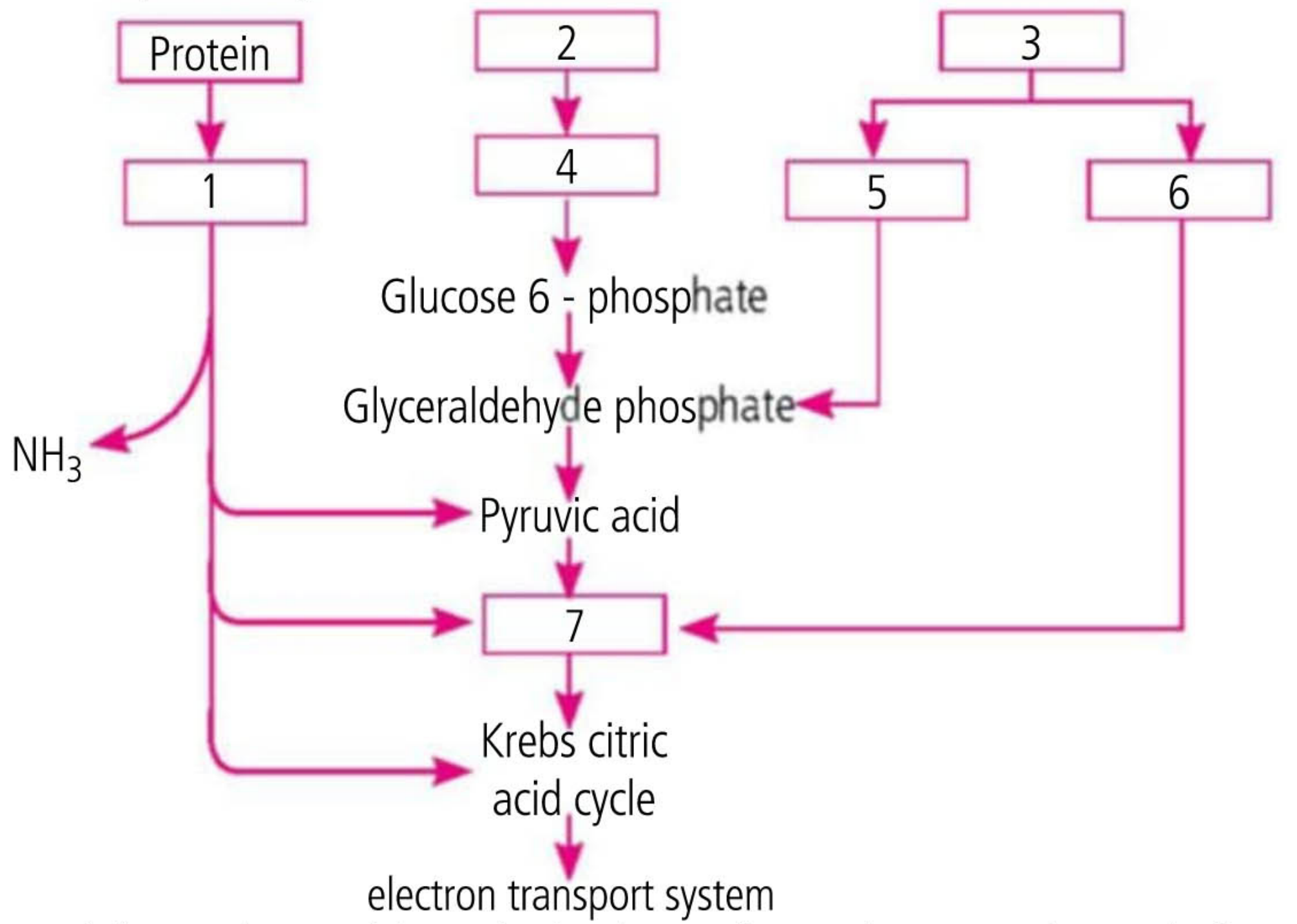
2. Following is a DNA profile of five individuals of which two are parents. Which of the remaining profiles belong to children of these parents?
(a) A and D
(b) C and E
(c) B and C
(d) C and D



(2018)

NSO

3. The following flowchart represents the cellular respiration and its fuels. Identify the substances in empty boxes 1 to 7 respectively.



(a) amino acid, carbohydrate, fats, glucose, glycerol, fatty acid, acetyl CoA
(b) fats, acetyl CoA, amino acid, fatty acid, carbohydrate, glycerol, glucose
(c) fatty acid, glucose, acetyl CoA, glycerol, fats, carbohydrate, amino acid
(d) carbohydrate, fats, glycerol, fatty acid, amino acid, glucose, acetyl CoA *(Fourth, Level II)*

4. A patient of diabetes mellitus excretes glucose in the urine even when he is kept on carbohydrate free diet. The most likely reasons for this is that
(a) amino acids are catabolised in the urea and from sugar
(b) amino acids are discharged in the blood stream from liver
(c) fats are catabolised to form glucose
(d) glycogen from muscles is released into the blood stream *(Fifth, Level II)*

CANADIAN BIOLOGY OLYMPIAD

5. A geneticist crossed *YYRR* (yellow-round) peas with *yyrr* (green-wrinkled) peas and self-pollinated the F_1 to produce F_2 offspring. In the F_2 generation what proportion of the yellow-round individuals were pure-breeding (homozygous for both genes)?
(a) 1/6 (b) 3/16 (c) 1/4 (d) 1/9
(e) 9/16 *(Eleventh)*

6. Bacteria that live in vents on the ocean floor (where hot magma superheats the water) have an extremely high proportion of guanine and cytosine in their DNA. Which statement best explains why this bacterial DNA is very stable in hot temperatures?
(a) The high guanine and cytosine content means the strands of bacterial DNA are less likely to be anti-parallel
(b) The chemical structure of purines makes them more heat stable
(c) The chemical structure of pyrimidines makes them more heat stable
(d) Guanine and cytosine base-pair with three hydrogen bonds; while the other nucleotides base-pair with two hydrogen bonds
(e) The phosphate bridges that allow adenine and thymine to base-pair are very unstable in hot environments. *(Eleventh)*

AUSTRALIAN BIOLOGY OLYMPIAD

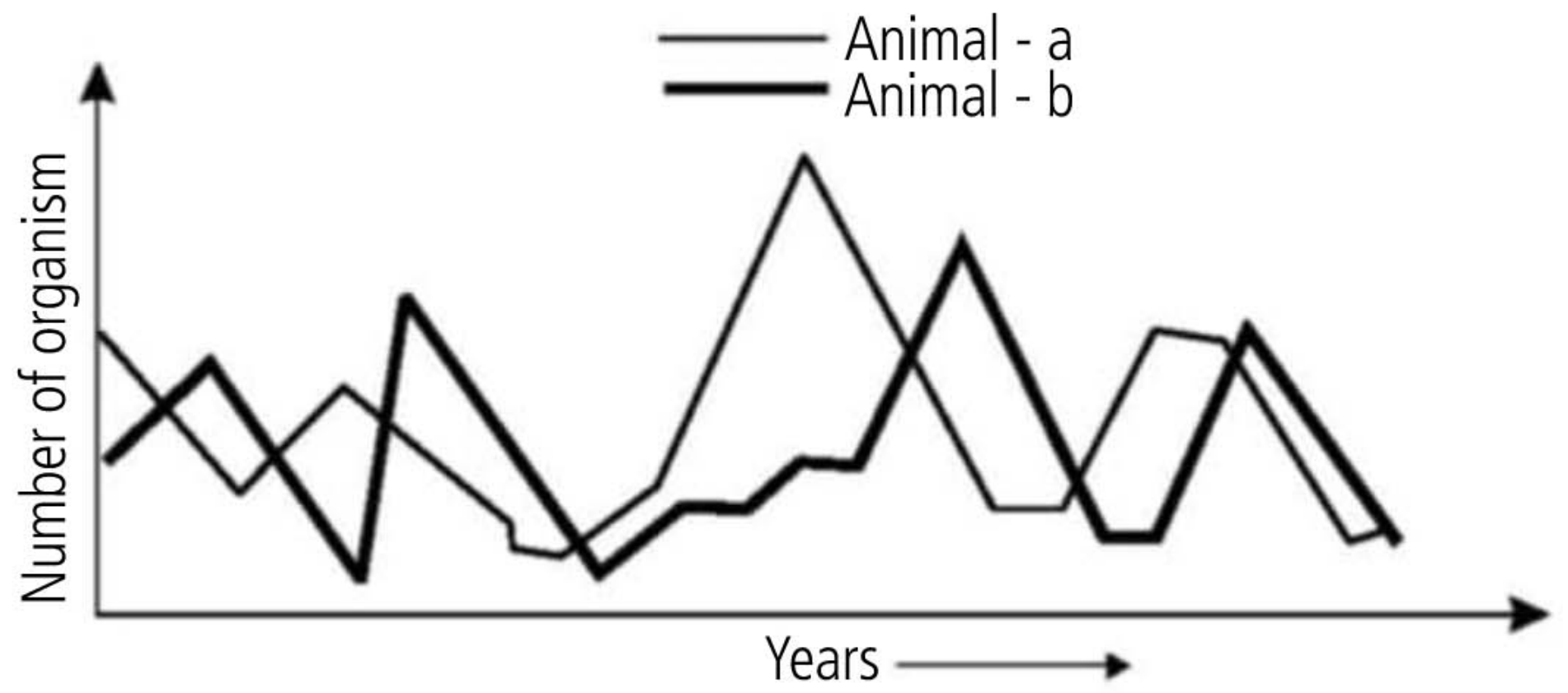
7. Scientists calculated that a particular piece of rock with a fossil imprint of an extinct species contained about 16g of radioactive isotope when it was formed. The rock was found to now contain 4g of the same radioactive isotope. If the half-life of the radioactive isotope is 100,000 years, how long ago did the extinct species exist?
(a) 100,000 years ago (b) 200,000 years ago
(c) 300,000 years ago (d) 400,000 years ago *(First)*

8. Bees communicate with each other about the location of food sources (flowers) by
(a) using high pitched noises generated by beating their wings to give directions to others
(b) secreting hormones in their hives to form a kind of a map for others to read
(c) performing a dance in the hive to indicate the direction from the hive relative to the sun
(d) forming grooves in the wax in the hive to form a kind of a map for others to read
(e) Orienting their chambers in the hive to indicate the direction from the hive relative to the sun *(Fourth)*

NSEB

9. A molecular biologist analysed a DNA sample and found that it contained the nucleotide bases in following proportion : A : T : G : C : : 1 : 1.33 : 0.98 : 0.65. This data indicates that :
(a) DNA sample is highly thermolabile
(b) DNA sample is from a eukaryotic cell
(c) DNA in the sample is single stranded
(d) more data required for any deduction. *(Second)*

10. In the given Hare and *Lynx graph* line *b* represents



(a) predator (b) prey
(c) inhibitor (d) intraspecies competition
(First)

SOLUTIONS

1. **(b) :** The given cladogram represents the evolution of different plant groups from a common ancestor. In mosses, the plant body is gametophytic which is independent whereas zygote develops as a multicellular sporophyte which remains dependent on female gametophyte. Ferns are pteridophytes which have small, free living gametophyte. Here the zygote begins life attached to the gametophyte but soon developed into a large and independent sporophyte. In gymnosperms and angiosperms, plant body is free living sporophyte and gametophyte is not independent. So here Q will be the right answer.

2. **(d) :** The given figure represents the DNA fingerprinting profile of five individuals. This technique can be used to determine the biological parent/biological child of any individual. The DNA of an individual is the same in every somatic (nonreproductive) cell. Sexual reproduction brings the DNA of both parents together randomly to create a unique combination of genetic material in a new cell, so the genetic materials of an individual is derived from the genetic material of both their parents in equal amounts. Comparing the DNA sequence of an individual to that of another individual can show whether one of them was derived from the other. However, DNA paternity tests are not currently 100% accurate. Specific sequences are usually looked at to see whether they were copied verbatim (exactly same) from one of the individual's genome to the other. If that was the case, then the genetic material of one individual could have been derived from that of the other (*i.e.*, one is the parent of the other). Besides the nuclear DNA in the nucleus, the mitochondria in the cells also have their own genetic material termed the mitochondrial DNA. Mitochondrial DNA comes only from the mother, without any shuffling.
Here in this case, column A and B represents parents' profile and column C and D represents the children profile as both C and D have some common DNA bands that resembles to their parental bands *i.e.*, A and B. In column E, DNA bands are entirely different from A, B, C and D, so it can not be the parent or child in any case.

3. **(a) :** 1. Amino acid, 2. Carbohydrate, 3. Fats, 4. Glucose, 5. Fatty acid, 6. Glycerol and 7. Acetyl CoA.
The given figure represents the cellular respiration using different respiratory substrates. If proteins are used as the respiratory substrates, they first converted to amino acids, during their conversion to pyruvic acid and ammonia is liberated. Second respiratory substrate is carbohydrate, which on decomposition converted to glucose and then to glucose-6-phosphate and finally to pyruvic acid, this is called glycolysis. The third respiratory substrate is fat, which on decomposition converted to glycerol and fatty acid. The pyruvic acid synthesised in glycolysis converted to 2 molecules of acetyl CoA, which further entered in to Krebs cycle.

4. **(c) :** The patient of diabetes mellitus is unable to produce or fail to utilise insulin hormone. Thus, he is unable to store glucose in the form of glycogen. Hence, he starts to excrete glucose in the urine. Even if a patient is kept on carbohydrate free diet, he excretes glucose in urine because high level of blood glucose not only depends on dietary carbohydrates but also on glycogenolysis (degradation of glycogen in liver) and gluconeogenesis (breakdown of fats into glucose in adipose tissues).

5. **(d) :** The cross between the yellow round peas with green wrinkled peas will provide all plants with yellow and round seeds as yellow colour and round shape in seeds are dominant characters over green and wrinkled seeds.
Parents YYRR X yyrr
(Yellow round) ↓ (Green wrinkled)
F_1 generation YyRr
(Yellow round)
↓
Selfing

F_2 generation :

	YR	Yr	yR	yr
YR	YYRR Yellow Round	YYRr Yellow Round	YyRR Yellow Round	YyRr Yellow Round
Yr	YYRr Yellow Round	YYrr Yellow Wrinkled	YyRr Yellow Round	Yyrr Yellow Wrinkled
yR	YyRR Yellow Round	YyRr Yellow Round	yyRR Green Round	yyRr Green Round
yr	YyRr Yellow Round	Yyrr Yellow Wrinkled	yyRr Green Round	Yyrr Green Wrinkled

Phenotypic ratio: 9:3:3:1. (Yellow Round: Yellow Wrinkled: Green Round: Green Wrinkled)

F_1 generation on selfing will produce four types of gametes and the phenotypic ratio in F_2 generation will be 9:3:3:1. Only 1 out of 9 yellow round seeded plant will be homozygous for both the genes.

6. **(d) :** Genomic DNA base composition (GC content) is predicted to significantly affect genome functioning and species ecology. One important feature of the GC base pair is its higher thermal stability compared with the AT base pair. This feature arises from the stronger stacking interaction between GC bases and the presence of triple hydrogen bonds between the paired bases. In turn, these interactions seem to be important in conferring stability to higher order structures of DNA and RNA transcripts. In bacteria, for example, an increase in GC content correlates with a higher temperature optimum and a broader tolerance range for a species. Selection for higher thermal stability has also been suggested to explain the evolution of GC-rich regions in the genomes of homeothermic vertebrates in contrast to their GC-poor homologs found in poikilothermic (*i.e.*, cold-blooded) groups, such as fishes and amphibians.

7. **(b) :** During natural radioactive decay, not all atoms of an element are instantaneously changed to atoms of another element. The decay process takes time and there is a value to express the rate at which the process occurs. It is called half-life ($t_{1/2}$), which is the time required for half of the starting material to change or decay. Half-lives can be calculated from measurements on the change in mass of a nuclide and the time it takes to occur. The only thing we know is that in the time of that substance's half-life, half of the original nuclei will disintegrate. Although chemical changes were sped up or slowed down by changing factors such as temperature, concentration, etc, but these factors have no effect on half-life. Here, the half-life of radioactive isotope is 100,000 years. The initial amount of the radioactive isotope was 16 gm and the present amount is 4 gm, *i.e.*, 1/4th of the initial amount. The radioactive isotope must have gone under two half life cycles.

$$16\text{ gm} \xrightarrow[\text{First half life}]{} 8\text{ gm} \xrightarrow[\text{Second half life}]{} 4\text{ gms}$$

To calculate the age of a substance by using formula : Age of radioactive material = $n \times t_{1/2}$

where, n = No. of half-lives, $t_{1/2}$ = Half life.

So, the isotope took, 2 × 100,000 or 200,000 years to reach at 1/4th of its initial concentration therefore the age of the fossil is 200,000 years.

8. **(c) :** Honey bees communicate to nestmates the locations of resources, including food, water, tree resin (propolis) and nest sites, by making waggle dances. Dances are composed of repeated waggle runs, which encode the distance and direction from the hive or swarm to the resource. Distance is encoded in the duration of the waggle run, and direction is encoded in the angle of the dancer's body.

The waggle dance can be regarded as a repetition of movements consisting of a waggle "run" and a return run. During the waggle run, the dancer swings her body from side to side in a pendulum-like manner, 13-15 times per second, and produces dance sounds by vibrating her wings. The bee moves her body continuously forward, but her legs do not move at all or perform only a few slow-motion strides. In the return run, the dancer circles back to start a new sequence. Some parameters of the waggle run are correlated with the location of the advertised feeding site. The angle between the sun's azimuth (the direction of a celestial object) and the direction to food in the field related to the waggle run angle. The distance to the food source is also indicated by the duration of the waggle run: the longer the duration of the waggle run, the further away is the feeding site.

9. **(c)** According to the Chargaff's rule, DNA from any cell of any organisms should have pyrimidine and purine base pairs in equal amount and, more specifically, that the amount of guanine should be equal to cytosine and the amount of adenine should be equal to thymine. Here the DNA sample in question is not following the Chargaff's rule. This is because Chargaff's rule only applicable to double-stranded DNA, due to the complementary base pairing that occurs between A-T and C-G. Hence, the sample in question could be single stranded DNA so the Chargaff's rule is inapplicable to it, since it does not obey the standard Watson-Crick base pairing that is the molecular basis of Chargaff's rule. Single stranded DNA is found in prokaryotes and more thermostable than the eukaryotic DNA.

10. **(a) :** Here The given graph represents the Hare and *Lynx*/prey and predator relationship. Snowshoe hare is the primary food of the *Lynx*. The population cycles of these two species are closely linked. The graphs represented by animal-a and animal-b show relationship in which when the number of animal-b increases, the number of animal-a starts to decrease and reaches to minimum as animal-b reaches about to its maximum number. The number of animal-b then starts to decrease because of the scarcity or shortage of food and gradually decline to its minimum value. This pattern follows throughout the graph for number of years. As we know, when the number or populations of predators increase then the number of prey decreases because predators feed upon prey. Therefore 'a' represents number of Hare (Prey) and 'b' represents number of *Lynx* (predator).

❖❖

SCIENTISTS EXPRESS

Major Contributions of The Scientists in the Field of Plant Reproduction

Rudolph Jacob Camerarius (1665-1721) was a famous German botanist who experimentally demonstrated the existence of sexes in plants. He was the professor of natural philosophy at the university of Tubingen. Camerarius was one of the first workers to perform experiments on heredity. He contributed particularly toward establishing sexual differentiation in plants by identifying and defining the male (anther) and female (pistil) reproductive parts of the plant and also by describing their functions in fertilisation. He showed that pollen is required for this process.

G.B. Amici, (1786-1863) was an Italian astronomer, microscopist and botanist. His most important work was in improving the mirrors of reflecting telescope and especially in the designing of microscope. He was the first to observe the pollen tube. He also reported that anthers play the role of male sexual organs in plants and later observed pollen tubes travelling through the stigma and style of *Portulaca oleracea*. In 1830, he concluded that the pollen tubes elongate and ultimately come in contact with the ovule.

Leon Guignard (1852-1928) was a French pharmacist and botanist. His most important contributions were to embryology, cytology, fertilisation, morphology and development of seed. In 1882, he demonstrated that the embryo sac in flowering plants always develops from one of the hypodermal cells of the nucellus and also described the general character of eight-nucleate embryo sac in thirty six families of monocotyledons and dicotyledons.

Sergei Gavrilovich Nawaschin, (1857 –1930) was a Russian biologist. He discovered double fertilisation in plants in 1898. He reported that in two species of lily family (*Lilium martagon* and *Fritillaria tenella*) one of the two male nuclei that pass down the pollen tube unites with the egg cell and the other joins another pair of nuclei to form endosperm. Shortly after the Nawaschin's discovery the French botanist, Guignard reported similar observations. His paper was also recognised as independent discovery.

Panchanan Maheshwari (1904-1966) was an eminent botanist of India. He worked on embryological aspects and popularised the use of embryological characters in taxonomy. He established the Department of Botany, University of Delhi as an important centre of research in embryology and tissue culture. He also emphasised the need for initiation of work on artificial culture of immature embryos. He was one of the leading plant biologists who established the technique of test-tube fertilisation of angiosperms.

Please send your feedback for our new article by mail at editor@mtg.in

Rapid Fire - Revision

The questionnaire contains multiple choice questions from different topics covered in this issue for effective recapitulation.

1. Missing link between reptiles and mammals is
(a) *Seymouria* (b) *Lycaenops*
(c) *Ichthyostega* (d) *Cynognathus.*

2. Match the column I with column II and select the correct option.

	Column I		Column II
A.	Diplotene	(i)	Synaptonemal complex
B.	Metaphase	(ii)	Quiescent stage
C.	Zygotene	(iii)	Chiasmata
D.	G_0 phase	(iv)	Equatorial plate

(a) A-(iii), B-(ii), C-(iv), D-(i)
(b) A-(iv), B-(i), C-(iii), D-(ii)
(c) A-(iii), B-(i), C-(ii), D-(iv)
(d) A-(iii), B-(iv),C-(i), D-(ii)

3. Betelnut is composed of
(a) arecoline and red tannin (b) mescaline
(c) psilocybine (d) lysergic acid diethylamide.

4. Find the correct match.
(i) Mitotic poison – Colchicine
(ii) Lampbrush chromosome – Diplotene
(iii) Cytokinesis – Strasburger
(iv) Meiosis – Farmer and Moore
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)
(c) (i), (ii) and (iv) (d) (ii), (iii) and (iv)

5. Match column I with column II and select the correct option.

	Column I		Column II
A.	*Basilosaurus*	(i)	Connecting link
B.	*Passiflora*	(ii)	Atavism
C.	*Oxalis*	(iii)	Analogous organ
D.	*Euglena*	(iv)	Missing link

(a) A-(i), B-(iv),C-(ii), D-(iii)
(b) A-(iv), B-(ii), C-(iii), D-(i)
(c) A-(iv), B-(iii),C-(ii), D-(i)
(d) A-(iii), B-(ii), C-(iv), D-(i)

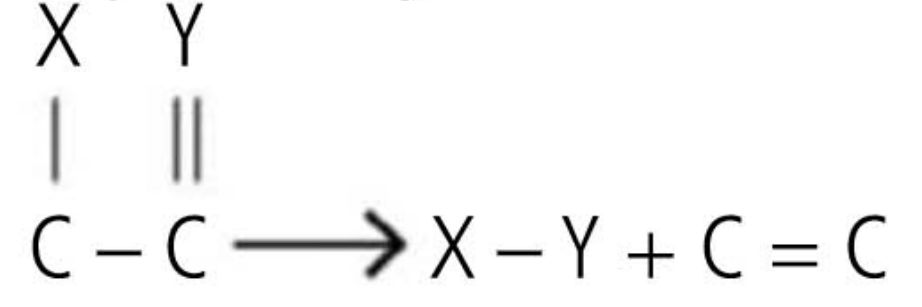
6. Read the given statements and select the correct option.

Statement A : In mitosis, chromosomes replicate and become equally distributed both quantitatively and qualitatively into two daughter nuclei.

Statement B : Mitosis produces multicellular condition.

(a) Statement A is false but B is true.
(b) Both statements A and B are true.
(c) Statement A is true but B is false.
(d) Both statements A and B are false.

7. Enzyme that catalyses the given reaction is



$$\overset{X}{\underset{|}{C}} - \overset{Y}{\underset{\|}{C}} \longrightarrow X - Y + C = C$$

(a) transferase (b) hydrolase
(c) lyase (d) dehydrogenase.

8. Prolonged use of drugs leads to
(a) kidney damage (b) AIDS
(c) hepatitis (d) all of these.

9. Read the given statements and select the correct option(s).
(i) Antibiotic resistance in bacteria is an example of natural selection.
(ii) Darwin's finches is an important example of sympatric speciation.
(iii) Coacervates hypothesis was given by Oparin.
(a) (i) and (ii) only (b) (i) and (iii) only
(c) (ii) and (iii) only (d) (i), (ii) and (iii)

10. ______ are nucleic acids.
(a) Lecithin (b) Alkaloids
(c) Inulin (d) Ribozymes

11. Combination of nicotine and cocaine on human body causes
(a) drowsiness (b) hypertension
(c) increased cardiovascular effects
(d) increased sedation.

12. Which of the following effect is also called genetic drift?
(a) Bottleneck effect (b) Founder effect
(c) Sewell Wright effect (d) Haldane effect

13. Select the correct examples of homologous organs.
(i) Thorn of *Bougainvillea* and tendril of cucurbita
(ii) Wings of insects and wings of birds
(iii) Mouth parts of cockroach and honeybee
(iv) Sting of honeybee and scorpion
(a) (i), (iv) and (ii) (b) (i) and (iv)
(c) (i), (ii) and (iii) (d) (i) and (iii)

14. Synthesis of DNA stops while formation of RNA and protein continues in
(a) G_1-phase (b) M-phase
(c) G_0-phase (d) G_2-phase.

15. Haemoglobin is a protein with
(a) tertiary structure (b) primary structure
(c) quaternary structure (d) secondary structure.

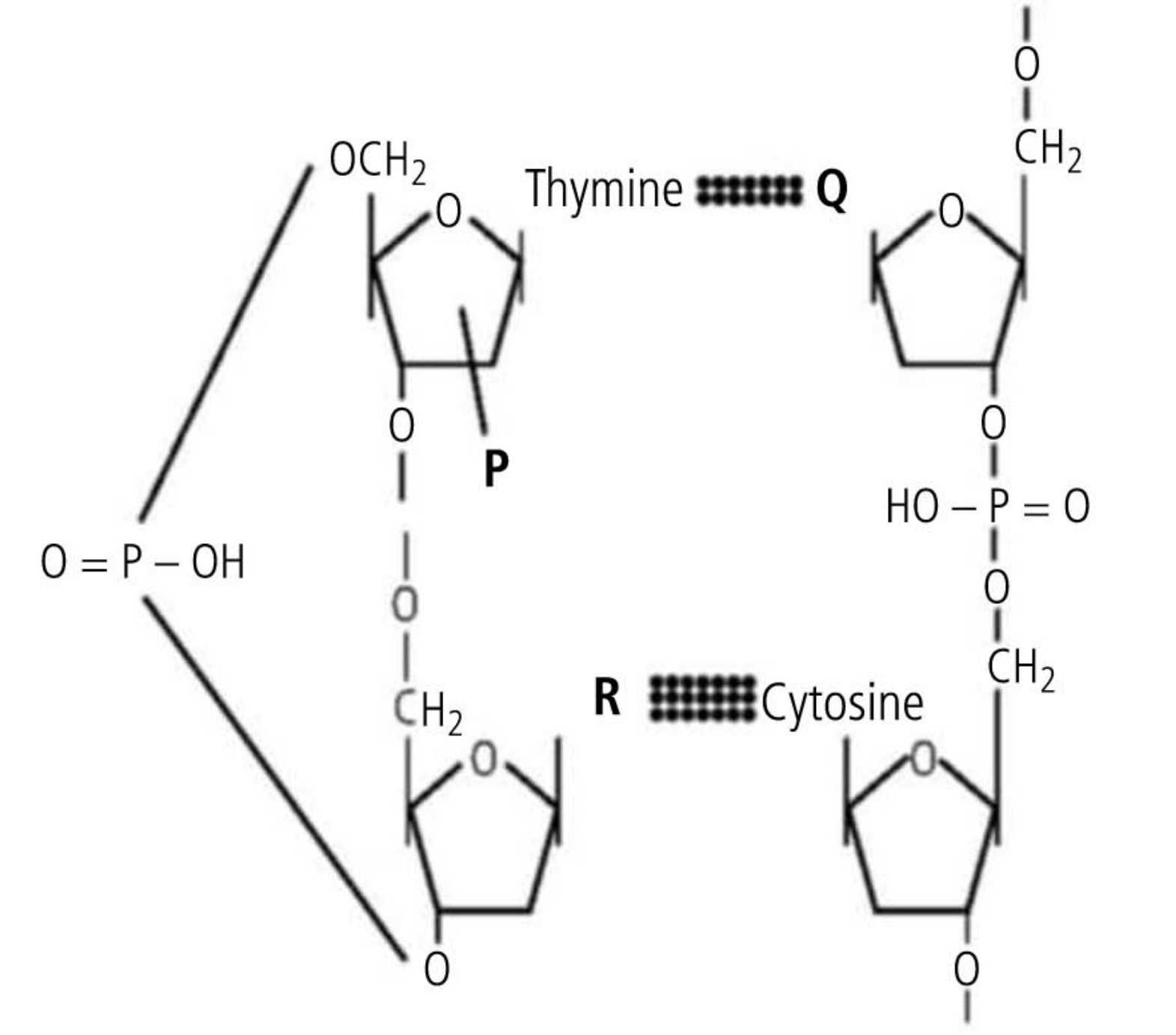
16. Select the correct match.
(a) *Australopithecus* – Middle pleistocene
(b) *Homo erectus* – Miocene
(c) *Homo habilis* – Pliocene
(d) *Homo sapiens* – Holocene

17. Hardy-Weinberg principle is applicable only when there is
(a) genetic drift (b) no gene flow
(c) no natural selection pressure
(d) both (b) and (c).

18. Synthetic hallucinogens are
(a) cannabinoids (b) phencyclidine piperidine
(c) methylenedioxy methamphetamine
(d) both (b) and (c).

19. Read the given statements and select the incorrect option.
(i) Uncontrolled mitotic division leads to cancer.
(ii) In plant cytokinesis, cell plate grows centripetally.
(iii) In animal mitosis, spindle poles possess centriole pairs.
(iv) Mitosis keeps all the somatic cells of an organism genetically similar.
(a) (i) and (ii) (b) (iii) and (iv)
(c) (ii) only (d) (iv) only

20. Refer to the given diagram and identify P, Q and R.



	P	Q	R
(a)	Ribose sugar	Cytosine	Guanine
(b)	Ribose sugar	Guanine	Adenine
(c)	Deoxyribose sugar	Adenine	Uracil
(d)	Deoxyribose sugar	Adenine	Guanine

21. Adaptive radiation occurring in an isolated geographical area can be seen in ______ and is called ______.
(a) Darwin finches, branching descent
(b) Darwin finches, divergent evolution
(c) Australian marsupials and placental mammals, convergent evolution
(d) Australian marsupials and placental mammals, divergent evolution.

22. Select the correct stage which shows the following key events.
(i) Chromosomes are seen with two chromatids attached together at the centromere.
(ii) Nucleolus or nucleoli degenerate, the two spindle poles begin to get connected by fine fibres.
(a) Metaphase (b) Prophase
(c) Anaphase (d) Telophase

23. A drug that is used as a sedative and pain killer is _____ and its source is _____.
(a) cannabinoid, *Atropa belladona*
(b) cocaine, *Erythroxylum coca*
(c) morphine, *Papaver somniferum*
(d) heroin, *Cannabis sativa*

24. The first human like being, *Homo habilis* had brain capacity between
(a) 900 cc - 1000 cc (b) 400 cc - 600 cc
(c) 650 cc - 800 cc (d) 1000 cc - 1400 cc

25. "The origin of life" book was published by
(a) Charles Darwin (b) Lamarck
(c) A.I. Oparin (d) Harold C. Urey.

26. Dyad formation takes place during which phase?
(a) Anaphase-II (b) Telophase-II
(c) Metaphase-I (d) Anaphase-I

27. In cell cycle, the phase that is also called energy phase is
(a) M-phase (b) Interphase
(c) G_2-phase (d) G_0-phase.

28. A sugar with 2000 – 20,000 units of glucose that gives red-violet colour with iodine solution is
(a) amylose (b) amylopectin
(c) glycogen (d) starch.

29. Inhibition of threonine deaminase by isoleucine is an example of
(a) allosteric inhibition (b) non-competitive inhibition
(c) competitive inhibition (d) irreversible inhibition.

30. Glyceraldehyde is a ______ sugar.
(a) pentose (b) triose
(c) hexose (d) tetrose

ANSWER KEY

1.	(b)	2.	(d)	3.	(a)	4.	(c)	5.	(c)
6.	(b)	7.	(c)	8.	(d)	9.	(b)	10.	(d)
11.	(c)	12.	(c)	13.	(d)	14.	(d)	15.	(c)
16.	(d)	17.	(d)	18.	(d)	19.	(c)	20.	(d)
21.	(c)	22.	(b)	23.	(c)	24.	(c)	25.	(c)
26.	(d)	27.	(b)	28.	(b)	29.	(a)	30.	(b)

☺☺

The questionnaire contains multiple choice questions based on current affairs and recent developments worldwide. Various facts are presented in question form to enable the students to develop knowledge as well as to test their general awareness skills and equip them with all essentials to crack various PMTs (AIIMS, et(c)). This will also help them to excel in other competitive exams like Banking and various Government recruitment exams.

1. Jagdeep Dhankar was sworn in as the Governor of which state?
(a) West Bengal (b) Haryana
(c) Maharashtra (d) Odisha

2. Which article has recently been removed by Indian Government that was used to ensure the special status to Jammu and Kashmir?
(a) Article 370 (b) Article 375
(c) Article 372 (d) Article 378

3. What was the theme of the G20 summit held in Germany in June 2019?
(a) Shaping an Interconnected World
(b) Fighting poverty with rigidity
(c) "Human-Centred Future Society"
(d) Making the world together

4. India's first female legislator in whose honour Google has created a doodle?
(a) Savitri Swami (b) Muthulakshmi Reddi
(c) Mamta Sharma (d) Aarti Narayan

5. Tropical storm that grew into a hurricane in the US was?
(a) Phyan (b) Vamei
(c) Erick (d) Clarke

6. The 20th anniversary of Kargil Vijay Diwas was celebrated on
(a) 25th July (b) 26th July
(c) 27th July (d) 30th July.

7. Chandrayaan-2 was launched from which of the following places?
(a) Porbandar (b) Pathankot
(c) Sriharikota (d) Pokhran

8. MS Dhoni is deployed with the Territorial Army Battalion in which state?
(a) Punjab (b) Jharkhand
(c) Sikkim (d) Jammu and Kashmir.

9. Which among the following countries has recently allowed women to travel abroad without approval from a male guardian?
(a) Saudi Arabia (b) Bahrain
(c) Turkey (d) Libya

10. Which among the following leader's claim that PM Modi asked him to be a mediator in Kashmir issue has been rejected by India?
(a) Kim Jong Un (b) Donald Trump
(c) Xi Jinping (d) Boris Johnson

11. India's campaign in the World Test Championship has already begun with which nation's tour?
(a) Sri Lanka (b) West Indies
(c) Australia (d) Bangladesh

12. India's fastest train, Vande Bharat Express recently completed trial run from New Delhi to Katra. What is another name of the Vande Bharat Express?
(a) Train 18 (b) Fastrack 20
(c) Bullet 18 (d) Quix 20

13. Which country has developed a method to convert Jute fibre into bio-Degradable plastic alternative called 'Sonali'?
(a) India (b) Bangladesh
(c) China (d) Japan

14. Which educational institute has launched AI App 'CARE4U' for the benefit of senior citizens?
(a) IIT Madras (b) IIT Kharagpur
(c) IIT Delhi (d) IIT Ahmedabad

15. Rain sensors filted on the windshield wipers of some automobiles are based on which of the following principles?
(a) Surface tension (b) Bernoulli's principle
(c) Total internal reflection
(d) Heat radiation

16. Which of the following is a constitutional body?
(a) National Development Council
(b) NITI Aayog
(c) Finance Commission
(d) None of these

17. Who is the author of the Book ' 'Across the Bench – Insight into the Indian Military Judicial System'?
(a) Gauri Lankesh
(b) Arundhati Roy
(c) Lt Gen Gyan Bhushan
(d) None of these

18. Which cricketer wrote down his autobiography titled '281 and beyond'?
(a) Sourav Ganguly (b) V. V. S. Laxman
(c) Rahul Dravid (d) Anil Kumble

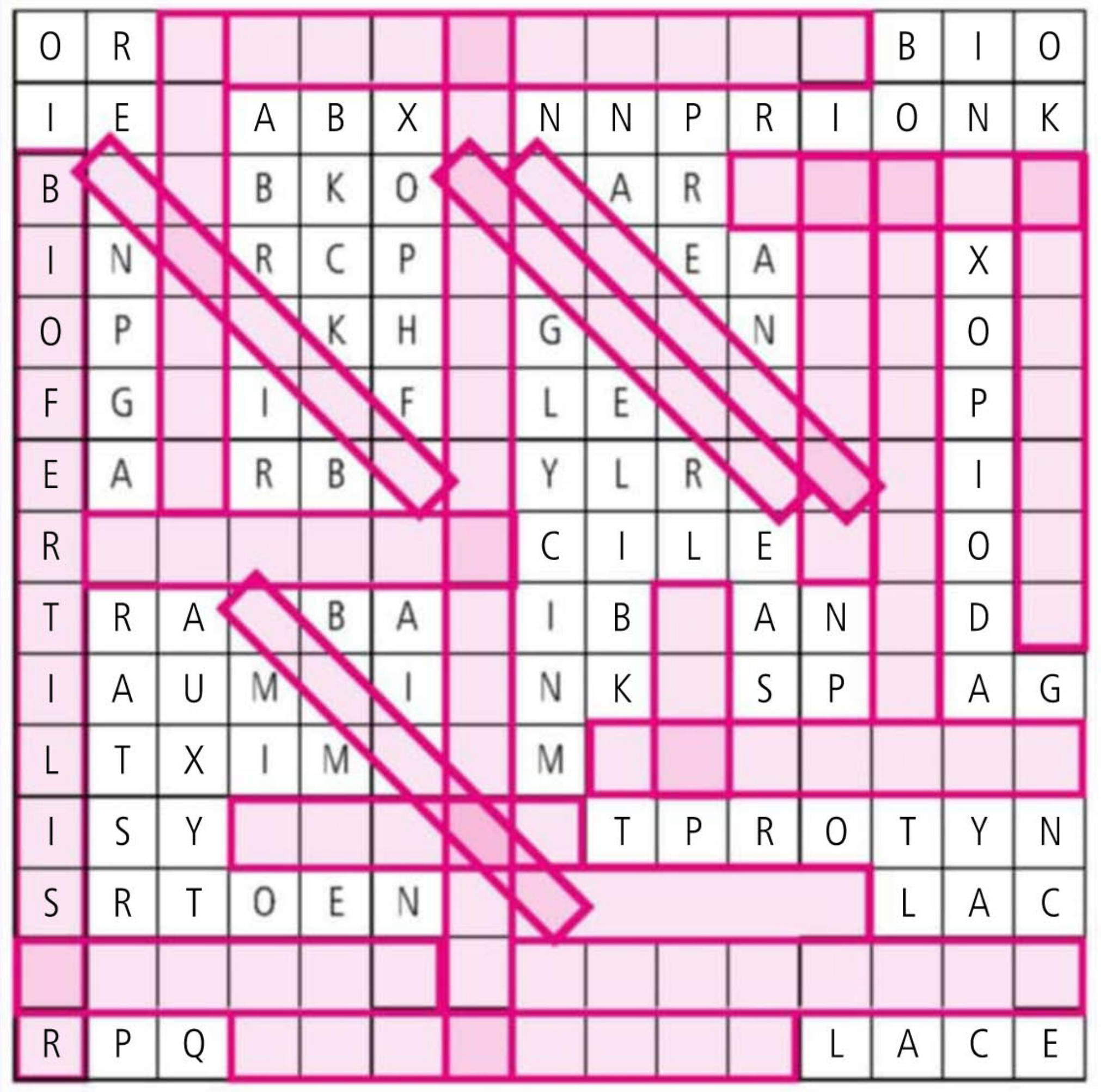
19. Who administers the oath of affirmation of the speaker of Lok Sabha?
(a) President of India
(b) Chief Justice of the Supreme Court
(c) Senior most member of the Lok Sabha
(d) None of these

20. What is the rank of India in Federation Internationale de Football Association(FIFA) ranking for the year 2019?
(a) 101 (b) 102
(c) 103 (d) 104

21. Which country has built first of its kind Underwater Military Museum?
(a) China (b) Italy
(c) Germany (d) Jordan

Contributed by : Jenifer Rajak, West Bengal,
Debanjali Banerjee, West Bengal

SOLUTIONS TO AUGUST 2019 WORD GRID



O	R											B	I	O
I	E		A	B	X		N	N	P	R	I	O	N	K
B			B	K	O			A	R					
I	N		R	C	P				E	A			X	
O	P			K	H		G			N			O	
F	G		I		F		L	E					P	
E	A		R	B			Y	L	R				I	
R							C	I	L	E			O	
T	R	A		B	A		I	B		A	N		D	
I	A	U	M		I		N	K		S	P		A	G
L	T	X	I	M			M							
I	S	Y						T	P	R	O	T	Y	N
S	R	T	O	E	N							L	A	C
R	P	Q									L	A	C	E

1. Biofertiliser
2. Stele
3. Viroids
4. Exarch
5. Gemmae
6. Genus
7. Fovea
8. Key
9. Phenylketonuria
10. Hilum
11. Menarche
12. Placenta
13. Syngamy
14. Taxon
15. Biopiracy
16. Auxins
17. Opsin
18. Exine
19. Xenogamy
20. Neoteny

22. Which one of the following statement is correct about "PACMATE"?
(a) It is world's fastest humanoid robot.
(b) It is world's first mobile phone made for visually challenged
(c) It is world's first talking computer.
(d) It is a computer virus which crashed e-mail networks.

23. Which among the following nations fired two projectiles toward East Sea?
(a) Japan (b) North Korea
(c) Russia (d) South Korea

24. What is the target (in terms of GDP) of Fiscal Deficit for Financial year 2019-20?
(a) 3.1% (b) 3.5%
(c) 3.3% (d) 4.4%

25. Who is the current chairman of the National Human Rights Commission?
(a) Justice A.S. Anand
(b) Justice H.L. Dattu
(c) Justice S. Rajendra Babu
(d) Justice K. Balakrishnan

26. Who is the current Chief Information Commission in India?
(a) Rajiv Mathur (b) Vijai Sharma
(c) Radha Krishna Mathur (d) Sudhir Bhargava

27. ISSF (International shooting sports federation) world cup 2020 will be hosted in _________
(a) Israel (b) India
(c) Australia (d) USA

28. Which institution or body passed the transgender persons (Protection of Rights) Bill 2019 on 5 August 2019?
(a) Lok Sabha (b) Rajya Sabha
(c) Governor (d) President

29. Which among the following ships was commissioned into the Indian Navy on July 29, 2019?
(a) LCU L-30 (b) LCU L-51
(c) LCU L-56 (d) LCU L-63

30. Which of the following Indian politician who was former Minister of External Affairs died recently?
(a) Atal Bihari Bajpai (b) Sushma Swaraj
(c) Somnath Chatterjee (d) Balramji Das Tandon

ANSWER KEY

1.	(a)	**2.**	(a)	**3.**	(c)	**4.**	(b)	**5.**	(c)
6.	(b)	**7.**	(c)	**8.**	(d)	**9.**	(a)	**10.**	(b)
11.	(b)	**12.**	(a)	**13.**	(b)	**14.**	(b)	**15.**	(c)
16.	(c)	**17.**	(c)	**18.**	(b)	**19.**	(d)	**20.**	(c)
21.	(d)	**22.**	(c)	**23.**	(b)	**24.**	(c)	**25.**	(b)
26.	(d)	**27.**	(b)	**28.**	(a)	**29.**	(c)	**30.**	(b)

☺☺

Readers' CAFE

Dear Readers,

We have been receiving a lot of queries from students and their parents, so we decided to ease you out by introducing a new column to guide you through your worries, concerns and questions related to your studies and beyond. Readers can send their queries (concerns beyond specific subjects, career guidance, tips for better performance, etc.) by post or by email at editor@mtg.in. The solutions to your queries given by MTG experts will definitely ease your anxiety and provide you a clear vision and a right direction to achieve your goals. Best and most relevant questions will be chosen and published with the sender's name.

Which are the top 10 medical colleges of India as per the ranking done by the National Institutional Ranking Framework (NIRF) in 2019?

Dinesh Jain, (Delhi)

Dear Dinesh, good to hear from a medical aspirant! National Institutional Ranking Framework (NIRF) ranking is an initiative of Govt. of India to encourage universities to enhance their research contributions to make it to international level. NIRF rankings 2019 for medical colleges was announced on Monday, 8th April, 2019 at a ceremony in Vigyan Bhawan, New Delhi. MHRD Minister Prakash Javadekar released the rankings for different categories for the colleges that participated in the ranking framework.

- This framework outlines a methodology to rank institutions across the country. The methodology draws from the overall recommendations broad understanding arrived at by a Core Committee set up by MHRD, to identify the broad parameters for ranking various universities and institutions. The parameters broadly cover "Teaching, Learning and Resources," "Research and Professional Practices," "Graduation Outcomes," "Outreach and Inclusivity," and "Perception.
- All India Institute of Medical Sciences (AIIMS) Delhi has topped the list with 90.71 per cent. In the top 10, two institutes are from Delhi and two from Uttar Pradesh, however medical colleges from Karnataka and Tamil Nadu dominates the list. Below is the list of top 10 ranked medical colleges:
    1. All India Institute of Medical Sciences, New Delhi
    2. Post Graduate Institute of Medical Education and Research, Chandigarh
    3. Christian Medical College, Vellore
    4. Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow
    5. Amrita Institute of Medical Sciences and Research, Coimbatore
    6. Banaras Hindu University, Varanasi
    7. Kasturba Medical College, Manipal
    8. Jawaharlal Institute of Post Graduate Medical Education and Research, Puducherry
    9. Institute of Liver and Biliary Sciences, New Delhi
    10. King George`s Medical University, Lucknow

What is the difference between NEET and JIPMER examinations? Is JIPMER easy to crack?

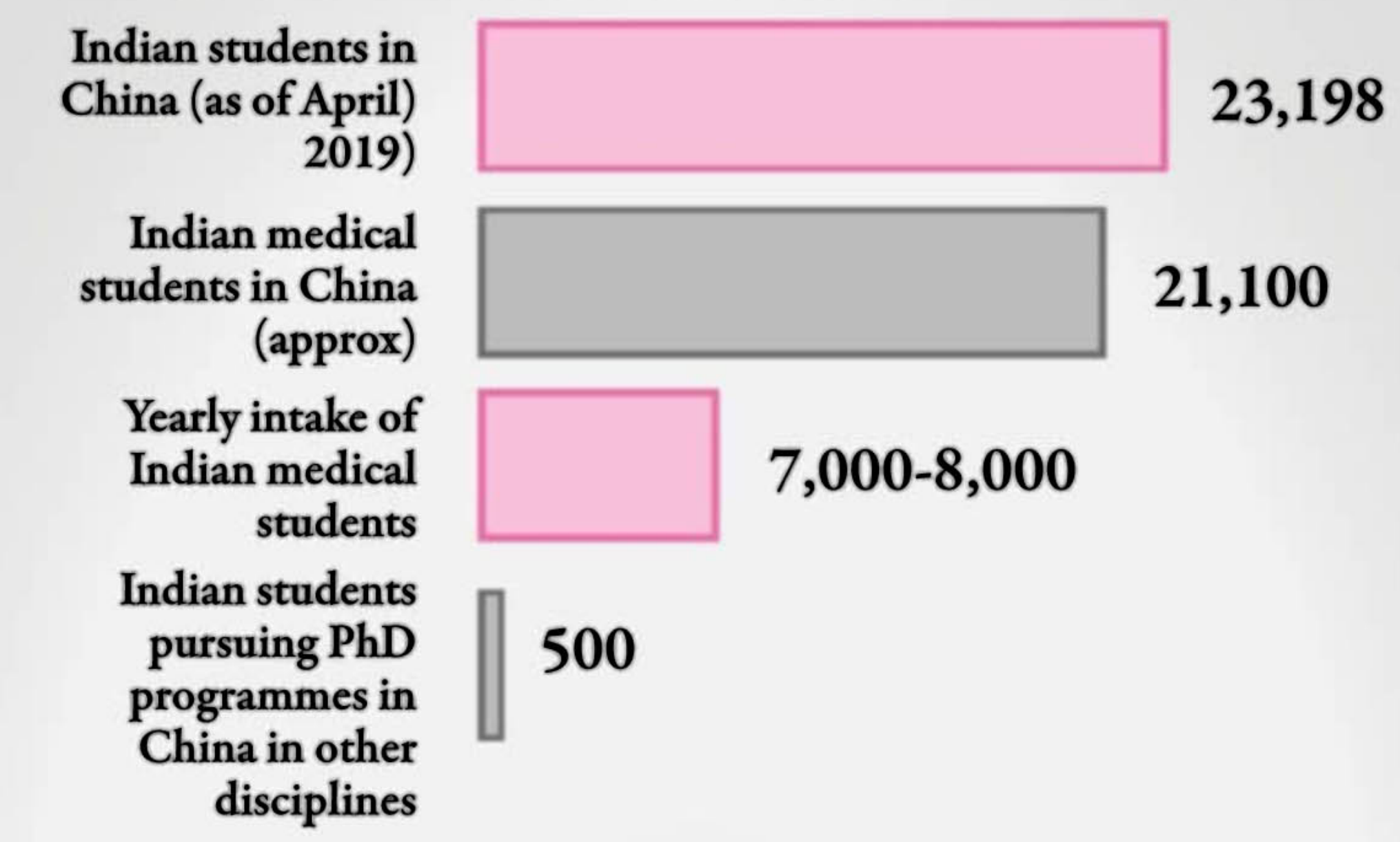
Rakhi Singh, (Jaipur)

Dear Rakhi, hey! None of these examinations is easy, all of these require equal efficiency and hard work. The main contrast between NEET and JIPMER examination is that NEET offers a significant number of seats for every one of the medical schools in India, while JIPMER has just 200 seats accessible for the MBBS course. However, the pattern of examination, mode of examination, etc., differs. The contrast between the exam pattern is clarified underneath:

- The method of JIPMER exam is online being a Computer Based Test (CBT). Here, the applicants need to practice the online mocks to get to know the idea of the online exam. While NEET exam is pen and paper-based exam where the applicant needs to fill the OMR sheet.
- The question count in JIPMER exam is 200 which should be solved in 2 hours and 30 minutes while the question count in NEET exam is 180 which should be answered in 3 hours. In examinations like AIIMS and NEET, students get an average of one minute to solve one question but in JIPMER the time is relatively less. It is truly evident that to clear the JIPMER exam; proper time management is also required.
- The JIPMER question paper will only be in English while the NEET exam, offers question paper in English, Hindi and also in other eight local languages such as Assamese, Gujarati, Tamil, Odiya, Bengali, Marathi, Telugu and Kannada.
- In the JIPMER exam, 4 marks will be given for each correct answer opted by the candidate and there is no negative marking for the wrong answer. While in the NEET exam, for each right answer, 4 marks will be awarded and for each wrong answer 1 mark will be deducted.
- As of now, the number of questions in JIPMER exam contains - Biology (60), Chemistry (60), Physics (60), Logical and Quantitative Ability (10) and English Language and Comprehension (10). While the question count in NEET exam include Biology (90), Chemistry (45) and Physics (45).
- One more important distinction is that JIPMER includes their state syllabus for exam. So, if you are preparing solely for NEET and AIIMS then you may find it difficult to cover that "extra" part. Hope my answer was helpful.

All the Best

Made in China


Indian students in China (as of April) 2019)
23,198
Indian medical students in China (approx)
21,100
Yearly intake of Indian medical students
7,000-8,000
Indian students pursuing PhD programmes in China in other disciplines
500

45 Total number of Chinese universities authorised to admit international students for MBBS degree in English (April 2019)

214 Estimate of number of universities across China where Indian medical students study

CHINESE MEDICAL INSTITUTIONS ELIGIBLE TO TAKE IN FOREIGN STUDENTS

2007-2008	30 universities, 2,095 seats
2012-2013	50 universities, 5,030 seats
2015-2016	45 universities, 3,470 seats
2019-2020	45 universities, 3,370 seats

(Source: MCI)

MEDICAL COLLEGES IN INDIA (INTAKE FOR 2019-2020)

GOVERNMENT	PRIVATE	TOTAL
301 colleges with 44,347 seats	272 colleges with 39,780 seats	573 colleges with 84,127 seats

(Source: Lok Sabha)

Every time she flew back from home in Anand, Gujarat, 24-year-old Rashi Patel would carry in her checked-in luggage men who had a lot to say and weighed on an average 3 kg. This is how Deepak Marwah, A K Setiya, Gobind Rai Garg, B D Chaurasia and K Sembulingam came to live in northeastern China, on her bookshelf at the Tianjin Medical University's (TMU) student dormitory.

Last winter, Patel scored 186 marks out of 300 in the Foreign Medical Graduate Exam (FMGE), a mandatory screening test conducted by the Medical Council of India (MCI) for students who obtain medical degrees from colleges outside India but are keen to practise medicine back home. The exam can be taken twice a year — June and December — starting from the student's internship year. To clear the "extremely tough" FMGE, Patel "thoroughly read Indian notes" day and night. "I mostly read Deepak Marwah sir's notes. They are very good," she says.

On July 1, 2019, Patel, along with 123 Indian students, graduated with an MBBS degree from TMU in a ceremony held at the university's indoor basketball court. She topped her batch, her smiling face captured in a poster affixed to a pole adjacent to the parking lot on the campus: "youxiù biyè sheng (excellent graduate student)", it read.

China, which has been offering undergraduate medical courses in English since around 2004, has over the years emerged as a destination for foreign students, mostly from the subcontinent. Since then, through a combination of hearsay and an informal network of private agents, thousands of aspiring doctors in India have opted for a Chinese medical degree.

For these Indians, whose dreams of donning the scrub are often stymied by fierce competition back home and the limited number of medical seats — 84,127 seats are on offer in a mere 573 colleges, government and private, in 2019-2020, according to the government's recent response in parliament — China is an attractive option, the country an emerging player in a market that has traditionally been dominated by Russia and other east European countries.

Patel is at the end of her China journey. So is her classmate Mrinalini K V S S, who is preoccupied with sending home four years of purchases made on Taobao, a Chinese online shopping website. "Mostly clothes," she says, laughing.

Originally bound for Nanjing Medical University in the eastern Jiangsu province, Mrinalini enrolled in TMU "by mistake" in 2013. "My agent messed up," she says. According to students The Sunday Express spoke to, the 'agent', a crucial conduit for this journey to China, can be anyone — a high school teacher, a friendly neighbourhood uncle, an NGO in rural Tamil Nadu, or seniors who graduated from medical schools in China but couldn't clear the FMGE. In one case, it was the student's uncle. This student even got a discount, but only on the commission he paid his agent-uncle.

Sunidhi Jhamb from Ludhiana in Punjab, who also graduated from TMU and came to China in November 2013, says that soon after her Class 12 results were out, her father received several phone calls from agents about medical courses in Ukraine, Russia and China. "Maybe the agents got the phone number from the forms that I filled up for medical entrance tests in India," she says.

Sitting in her room at the Foreign Students' Hostel in Cangzhou, a city in China's eastern Hebei province, Jhamb says, "I didn't have a choice back then. I was only getting a seat in dentistry at Rajpura (in Punjab's Patiala district), which I didn't want. My father knew someone whose relative was studying for an MBBS degree here. So we felt we could trust China."

Jhamb is among 57 international students — Indians and Sri Lankans — in her batch who have completed their internship at Cangzhou Central Hospital next door. She has now launched into full-time preparation for the FMGE.

* * *

On the face of it, a degree from China is an alluring option, says a former student who does not wish to be identified. "There are no criteria by which you get admitted to a course. If you have the money, you get admission," he says, adding that this is reflected in the quality of students who end up in China.

Around 7,000-8,000 Indian students travel to China every year for an MBBS degree. Though some universities specify their requirements — the need to have passed high school with a certain minimum percentage — in many other instances, students say, there are no entry barriers.

Says Madhurima Nundy, Associate Fellow of the Delhi-based Institute of Chinese Studies, "China is a good option for those not qualifying the public medical college exams (in India). Studying in China is far cheaper than studying in private medical colleges in India. Besides, some of these (Chinese) universities are rated high by international standards when compared to Russian universities."

Patel says her parents spent roughly Rs 30-40 lakh for her six years in China. A first-year student's fee structure, shared by an agent, adds up to around Rs 22.5 lakh a year, which includes tuition fee, hostel, food, health insurance, residential permit, physical examination, textbooks and "experiment material".

That makes Chinese colleges a good alternative to private medical colleges in India with their sky-high capitation fees. "My niece paid Rs 85 lakh in capitation fees for a seat in a private college in Pune," says 57-year-old Mumbai-resident Pawan Sharma, who chose to send his son Harshit to Tianjin.

Jose Akash, a fourth-year student from Trichy in Tamil Nadu who studies in Beijing's Capital Medical University (CMU), says, "My mother decided that I should be a doctor. In my generation, there are no doctors in the family. So I had to be one."

Akash's family had to shell out Rs 2.5 lakh as commission, apart from paying for the agent to travel alongside him on the flight to China — the agent even visited her relative on the pretext of dropping him off. Akash says he couldn't manage a seat in a medical college in Trichy in Tamil Nadu despite his family's connections in the DMK. "The AIADMK is in power in the state," he sighs.

Four years ago, all that Akash knew about China was what many Tamil children growing up in the late '90s and early 2000s knew: insight from Bruce Lee films dubbed in Tamil that played late in the night on Vijay TV. "I had no desire to come here. I had seen things about China which I thought I wouldn't like. But after I came here, I loved it. Have you checked out the Burger King in Beijing?" he asks.

* * *

For 2019, CMU is fourth on an approved list of medical universities prepared by China's Ministry of Education (MoE) that can accept international students. The list, which is released every year ahead of the admission season after a "thorough scrutiny of the English-medium standards including examining the infrastructure, amenities and proficiency of the faculty" of the universities offering medical education, is also uploaded on the MCI's website as a useful guide for aspiring medical students.

For this academic year, the list contains 45 medical universities across China, with 3,370 seats on offer. Many of the universities are concentrated in eastern provinces such as Jiangsu, Shandong and Zhejiang.

Official sources The Sunday Express spoke to said the overwhelming majority of foreign students in the 45 universities are Indian, many of them from South India. Besides, there are students from Bangladesh, Pakistan, Sri Lanka and some African countries, a source said.

Earlier this year, on April 29, the Embassy of India in Beijing said in a press release: "Prospective students are advised to note carefully that only these 45 Chinese Universities (mentioned in the list) are authorised to admit international students for an MBBS degree in English. They may also note the warning in the notification that teaching of MBBS courses under a bilingual (English/Chinese) model is strictly forbidden."

Nundy says this is a "good move" since there were many bilingual universities (about 214) of lower quality that were also listed till about 2017. "There is much variation in the curriculum and pedagogy across these universities when it comes to medical education for international students and there needs to be some kind of quality check," she says.

Though the language clause — which "strictly forbids" these medical schools from teaching bilingual MBBS courses to international students — is what draws international students, once they enrol, students realise early on that there is no escaping Mandarin while in China. The language training programme is an in-built component in the MBBS course and it runs for a minimum of three years. Also integrated into the syllabus are courses on traditional Chinese medicine and medical terms in Mandarin.

The language barrier is often cited as the main reason for Indian medical graduates not wanting to stay back in China. "In my final year of internship, half the time I was listening to patients and then turning to the doctors to know what they were saying," says Mrinalini, adding, "How can you help patients when you can't communicate with them? It becomes very frustrating."

To practise in hospitals in China, students say they must clear at least Level 5 of the Hanyu Shuiping Kaoshi or the Chinese proficiency test, which requires one to know 2,500 commonly used words and grammar patterns.

However, the former student says that while there are policies in place to mandatorily teach international students in English, the quality of teaching leaves a lot to be desired. "There are teachers who cannot speak English at all. They ask Chinese students who can speak English to read out loud and record PowerPoint presentations, which are then played in classrooms," he says, adding, "Over the years, this has led to universities requiring students to learn more Mandarin."

During role-plays in Chinese class during his first year, Manoj Sharma, a native of Cuddalore, Tamil Nadu, also from Patel's batch, was always the bingren (patient). "It is easy to memorise Chinese words for cough or fever and let the person who is acting as the doctor memorise the bigger words," he laughs. "But learning the language is necessary. It helped me make friends."

During his internship, Sharma often walked over to the park across the hospital where Chinese senior citizens practised martial arts. "Cangzhou is historically known for wushu or Chinese martial arts. The old men would teach me martial arts and introduce me to their friends as their Indian student," he says.

* * *

Courtesy : The Indian Express

mtG

Now, savings of up to ₹920* with MTG's magazine subscription plans!

*On cover price of ₹ 40/-

Our new offers are here!
Pick the combo best suited for your needs. Fill-in the Subscription Form at the bottom and mail it to us today.
If in a rush, log on to *www.mtg.in* now to subscribe online.

For JEE (Main & Advanced), NEET, AIIMS & JIPMER

About MTG's Magazines

Perfect for students who like to prepare at a steady pace, MTG's magazines (**Physics For You, Chemistry Today, Mathematics Today & Biology Today**) ensure you practice bit by bit, month by month, to build all-round command over key subjects. Did you know these magazines are the only source for solved test papers of all national and state level engineering and medical college entrance exams?

Over 1.2 Cr readers. Since 1982.

- Practice steadily, paced month by month, with very-similar & model test papers
- Self-assessment tests for you to evaluate your readiness and confidence for the big exams
- Content put together by a team comprising experts and members from MTG's well-experienced Editorial Board
- Stay up-to-date with important information such as examination dates, trends & changes in syllabi
- All-round skill enhancement – confidence-building exercises, new studying techniques, time management, even advice from past JEE/NEET/AIIMS toppers
- Bonus: Exposure to competition at a global level, with questions from International Olympiads & Contests

Lifetime Subscription Plan for teachers, and special schemes and offers available for libraries and coaching institutes. SMS MTG to 8800255334 to learn more.

SUBSCRIPTION FORM

Confirm your choice by placing ☑tick-marks in relevant boxes.

		27 months	15 months	9 months
Plan 1: Individual magazines P, C, M, B	☐ Physics ☐ Chemistry ☐ Mathematics ☐ Biology	☐ ₹850 (save ₹ 230)	☐ ₹500 (save ₹ 100)	☐ ₹300 (save ₹ 60)
Plan 2: Combo of 3	☐ PCM ☐ PCB	☐ ₹2500 (save ₹ 740)	☐ ₹1400 (save ₹ 400)	☐ ₹900 (save ₹ 180)
Plan 3: PCMB Combo		☐ ₹3400 (save ₹ 920)	☐ ₹1900 (save ₹ 500)	☐ ₹1200 (save ₹ 240)
Courier Charges *Add to your subscription amount for quicker & reliable delivery*		☐ ₹600	☐ ₹450	☐ ₹240

Recommended by *(Optional)*

Name of your teacher

Teacher's Mobile # ☐☐☐☐☐☐☐☐☐☐

Note: Magazines are despatched by Book-Post on 4th of every month (each magazine separately).

Name:
Complete Postal Address:
Pin Code ☐☐☐☐☐☐
Mobile # ☐☐☐☐☐☐☐☐☐☐
Other Phone # 0 ☐☐☐☐☐☐☐☐☐☐☐
Email

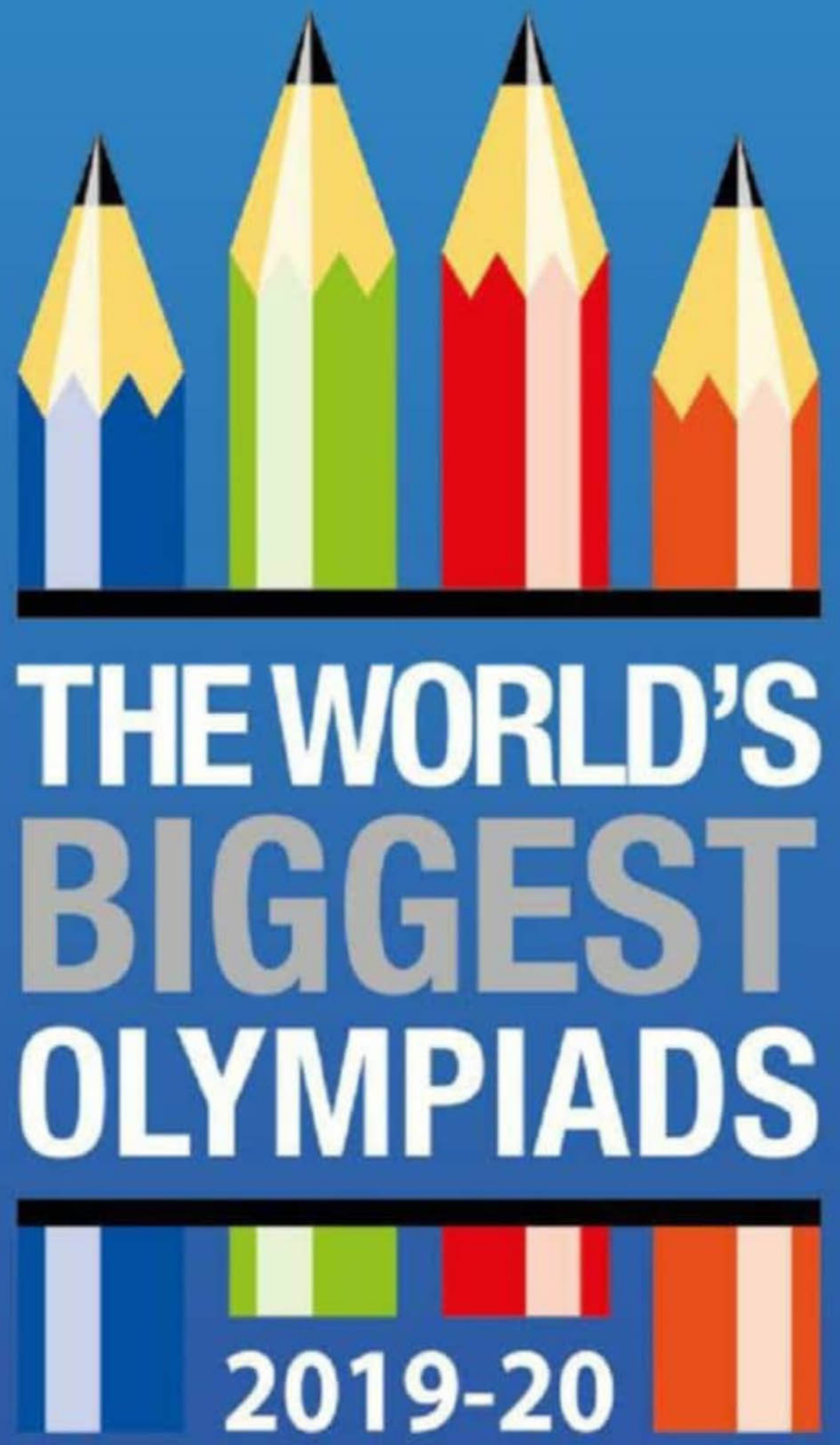
Enclose Demand Draft favouring
MTG Learning Media (P) Ltd, payable at New Delhi.
Mail this Subscription Form to Subscription Dept.,
MTG Learning Media (P) Ltd, Plot 99, Sector 44, Gurugram -122 003 (HR).

E-mail *subscription@mtg.in*. Visit *www.mtg.in* to subscribe online. Call (0)1800-10-38673 for more info.
Get digital editions of MTG Magazines on *http://digital.mtg.in/*

SOF
SCIENCE OLYMPIAD FOUNDATION
INSPIRING YOUNG MINDS THROUGH KNOWLEDGE OLYMPIADS
ANNOUNCES

Important:
Closing date
30 days
before date
of exam.

AWARDS* & PRIZES
- Total awards worth ₹18 Crores
  Over 10 Lac awards
- Medals to class toppers
- Certificates & Performance Analysis Reports for all schools & students


THE WORLD'S
BIGGEST
OLYMPIADS
2019-20

Millions of students from 50,000+ schools
in 1400+ cities and 30 countries competing
in the SOF Olympiads!

SCHOLARSHIPS
- Girl Child Scholarship Scheme - 300 Nos. ₹5,000 each
- Scholarship of Excellence in English-120 Nos. ₹5,000 each
- Academic Excellence Scholarship-160 Nos. ₹5,000 each +Trophy

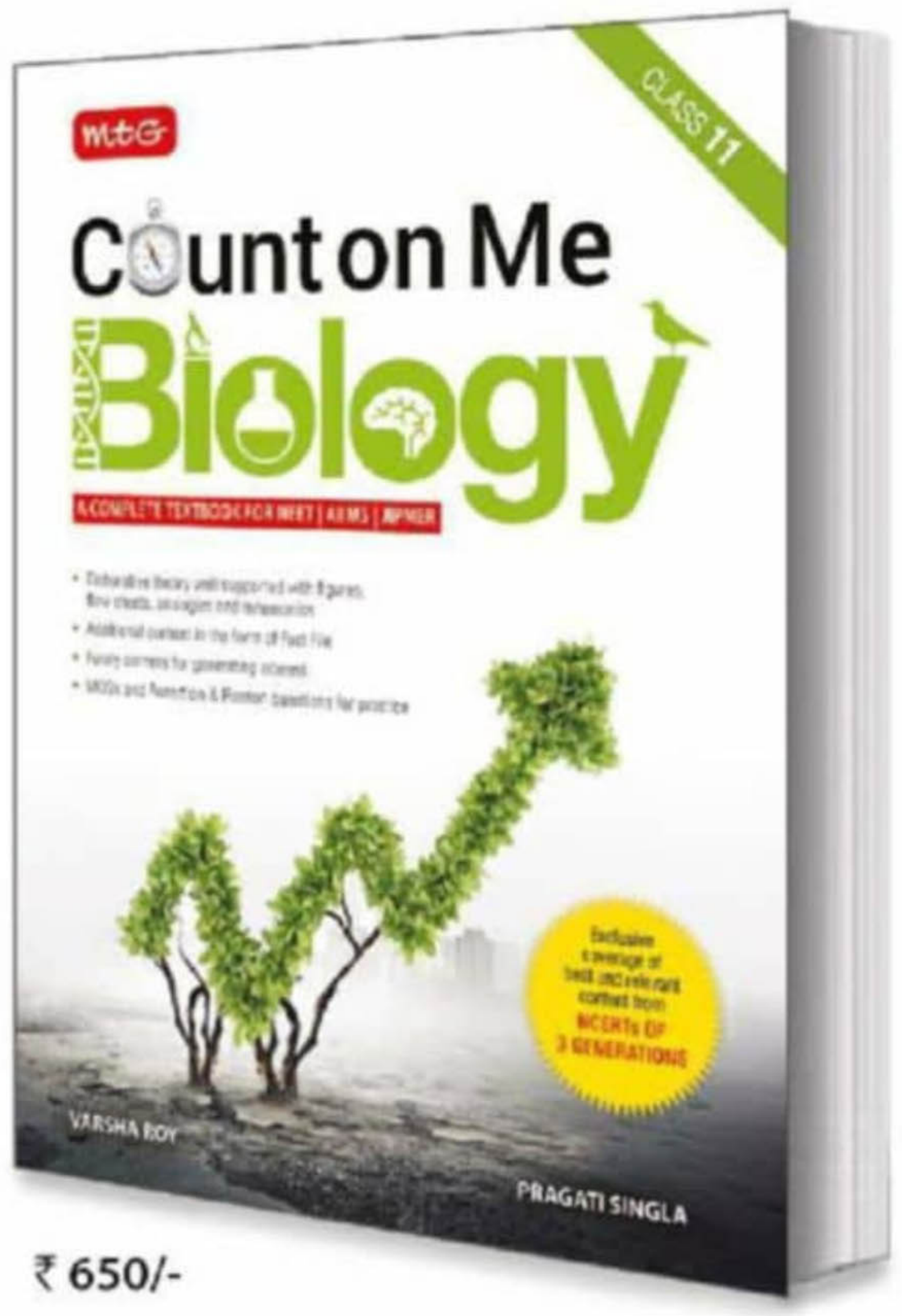
FOR DETAILS
- Visit www.sofworld.org
- Visit www.facebook.com/sofworld
- Write to us at info@sofworld.org
- Call : 0124 - 4951200
- Check with your teacher

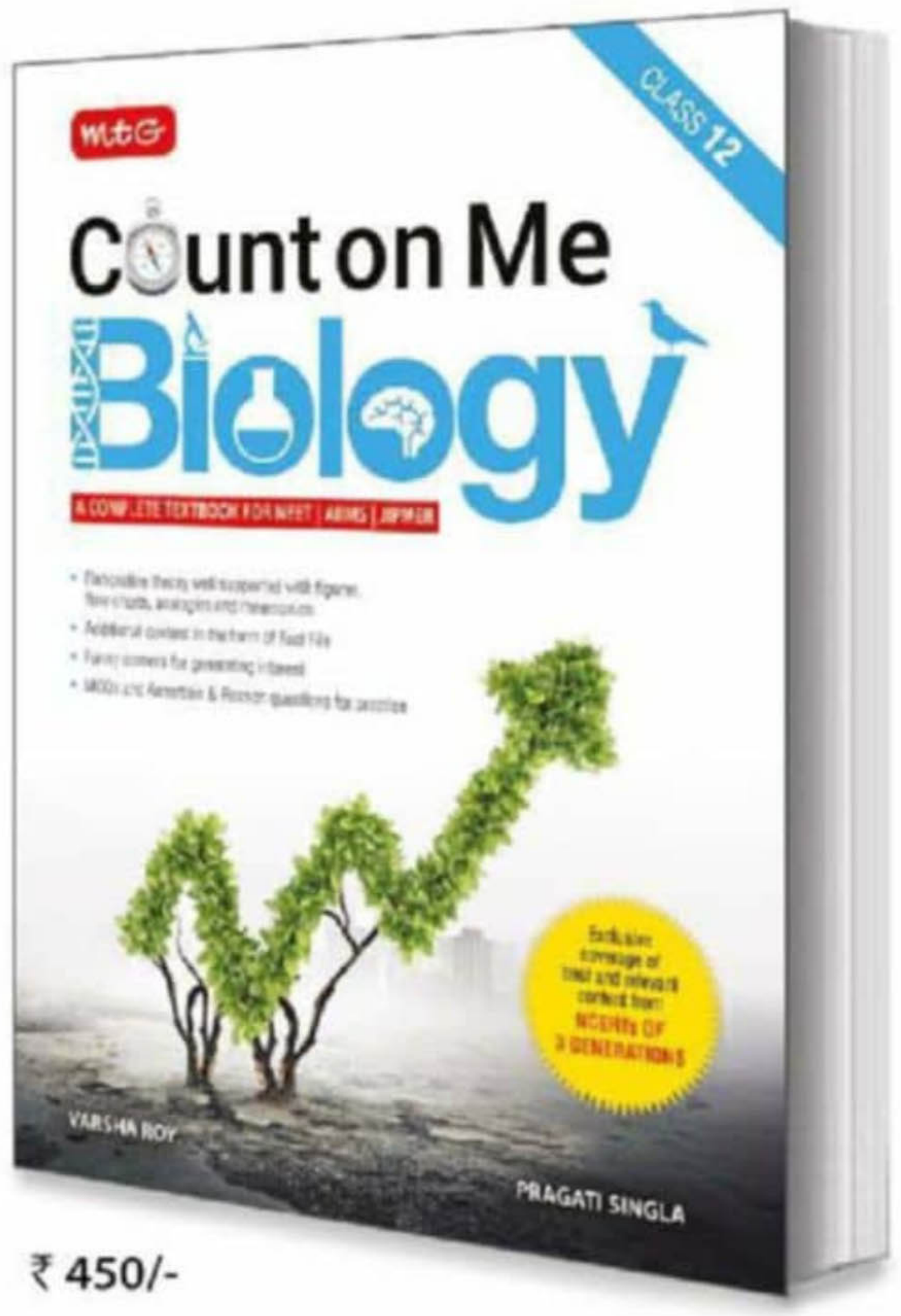
Olympiad	Name	Dates
IGKO	SOF INTERNATIONAL GENERAL KNOWLEDGE OLYMPIAD	SEPT. 6 & SEPT. 26
IEO	BRITISH COUNCIL PRESENTS SOF INTERNATIONAL ENGLISH OLYMPIAD	OCT. 15 & NOV. 5
NSO	SOF NATIONAL SCIENCE OLYMPIAD	NOV. 11 & NOV. 21
IMO	SOF INTERNATIONAL MATHEMATICS OLYMPIAD	DEC. 5 & DEC. 17
NCO	SOF NATIONAL CYBER OLYMPIAD	NOV. 28 & DEC. 19
ICO	INTRODUCING ICSI THE INSTITUTE OF Company Secretaries of India भारतीय कम्पनी सचिव संस्थान PRESENTS SOF INTERNATIONAL COMMERCE OLYMPIAD	NOV. 28 & DEC. 19

✓National office: Plot No. 99, First Floor, Sector 44 Institutional Area, Gurugram -122 003 (HR) Telefax: (0124)4951200, 09312680857/55
Regd. Office: 406, Taj Apt., Ring Road, New Delhi-110 029 | e-mail: info@sofworld.org
*T&C apply, please refer to prospectus & our site for details.

MTG

A valuable asset to your PMT collection


₹650/-


₹450/-

Count on Me is a complete textbook of biology that caters to different needs of students preparing for boards and competitive exams like NEET, AIIMS, JIPMER, etc. The content of this book is extraordinary and unparalleled, beating the conventional content presentation as provided in the contemporary titles available for biology. It covers the relevant content of NCERTs of three generations which makes it an all in one holistic study material.

It is a new ray of hope for bright future and assured success in the field of biology. Well begun is half done so choose the right study material. Don't waste time and go grab your copy.

Key Features
- Elaborative theory well supported with figures,flow charts, analogies and mnemonics
- Additional content in the form of Fact File
- Funny corners for generating interest
- MCQs and Assertion & Reason questions for practice

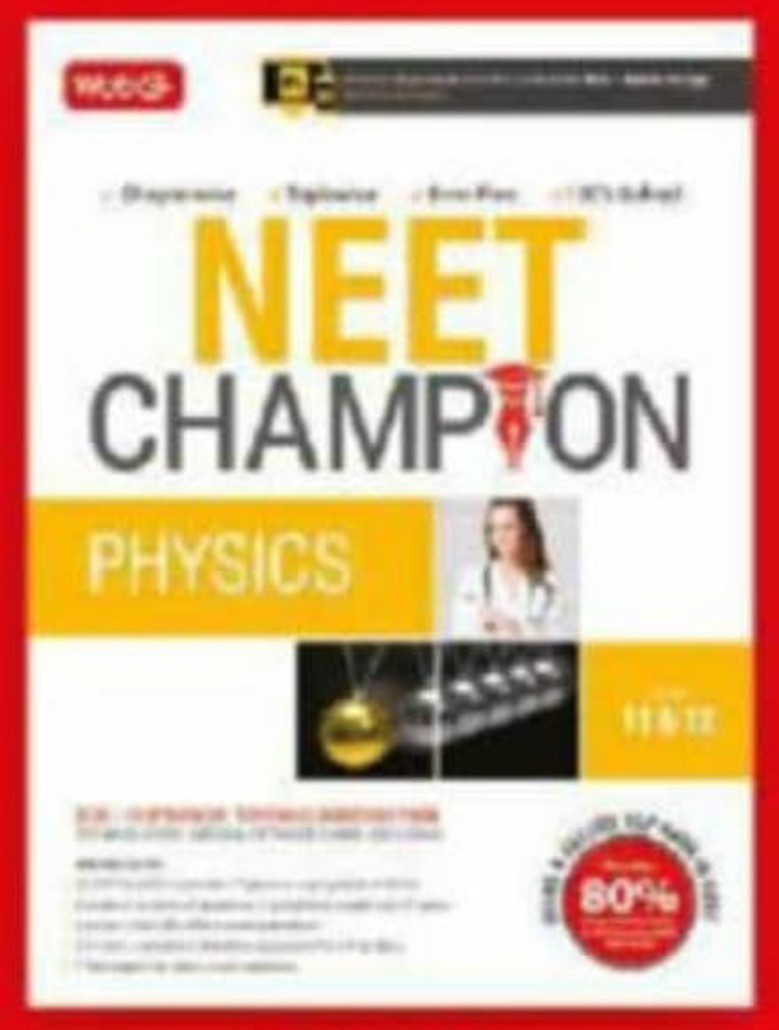
MTG Learning Media

Available at all leading book shops throughout the country.
For more information or for help in placing your order:
Visit **www.mtg.in** to buy online!
Call 0124-6601200 or e-mail:info@mtg.in

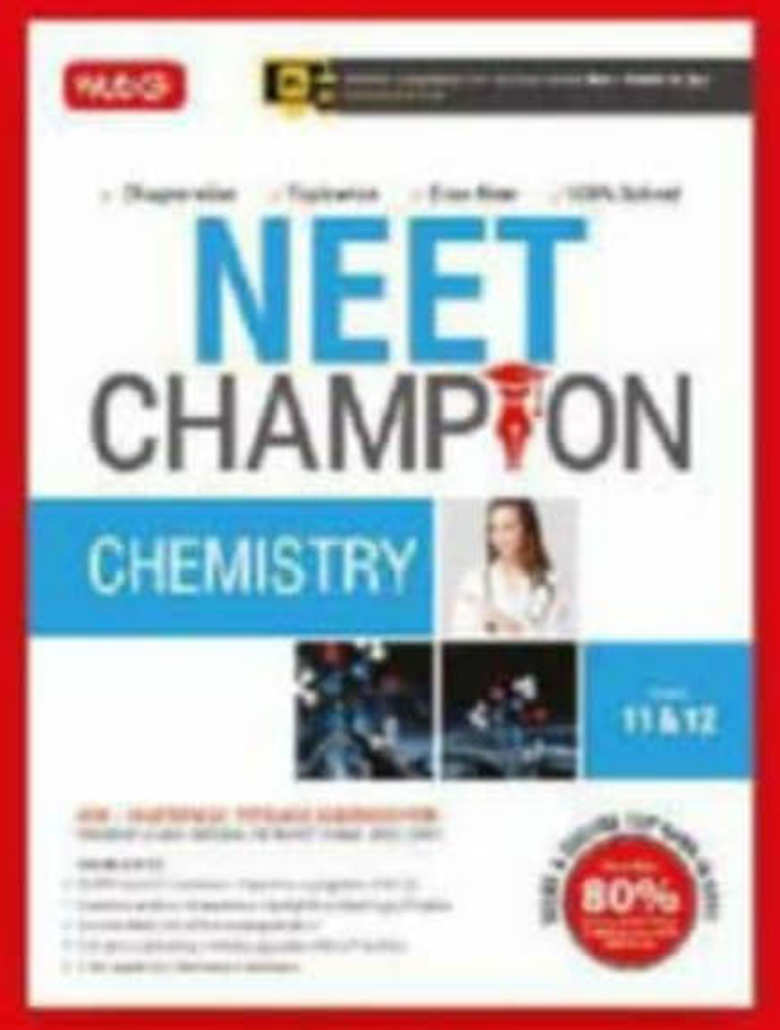
Visit **www.mtg.in** for latest offers and to buy online!

Skill. Passion. Hard work and determination. As a student sitting for the highly competitive NEET, you need all that. However, only a few will win, very likely with the help of a champion coach.

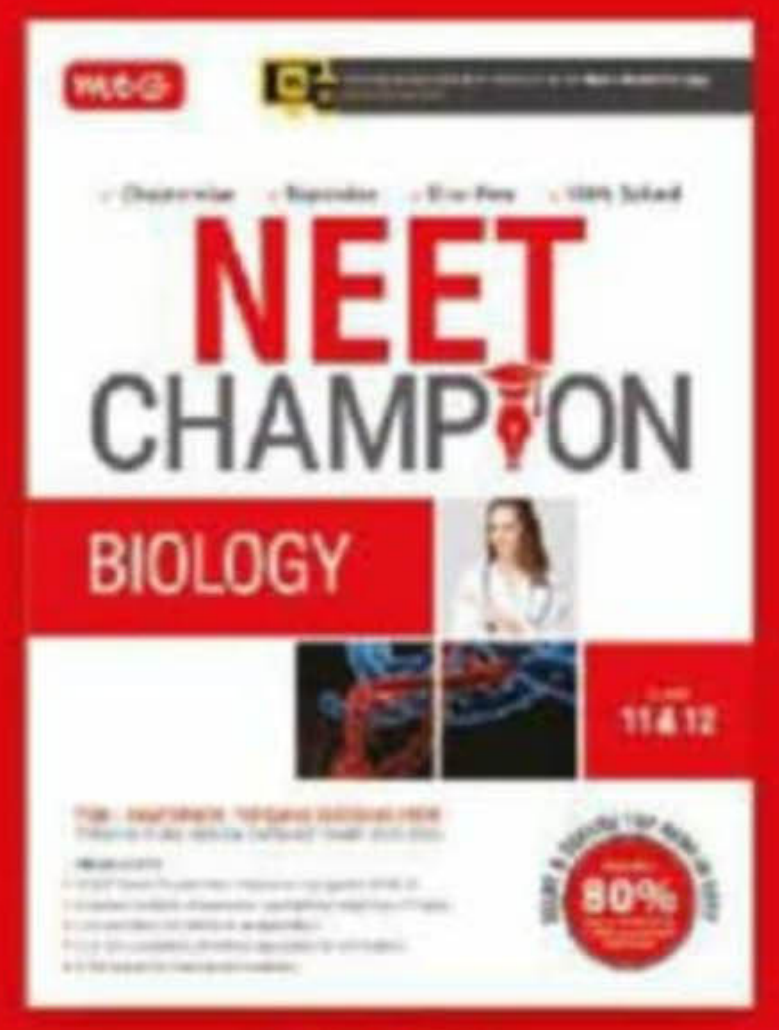
MTG's NEET Champion Series is just the coach you need. It will guide you in identifying what's important for success and what's not. And then help you check your readiness with its most comprehensive question bank.



₹800/-



₹800/-



₹800/-

So you know your strengths and weaknesses right from the word go and course-correct accordingly. Put simply, MTG's NEET Champion Series will help you manage your preparation effort for NEET for maximum outcome. The best part is you study at a pace you're comfortable with. Because it's all chapterwise, topicwise.

HIGHLIGHTS

NCERT-based • Chapterwise • Topicwise • 10 years' solved previous test papers (all major medical entrance exams) • Concise summary at the start of each chapter for quick revision of key concepts • Analysis of importance of topics basis historical examination pattern • Test papers for self-assessment

Attempt all questions from this book on the Web + Mobile for free
For details see inside the book

Visit www.mtg.in to buy online.
Or visit a leading bookseller near you.
For more information, call 1800-10-38673 (toll-free) or 0124-6601200 today.
Email *info@mtg.in*

CBSE CHAMPION Chapterwise -Topicwise Solved Papers

CBSE CHAMPION CHAPTERWISE-TOPICWISE PHYSICS
CBSE CHAMPION CHAPTERWISE-TOPICWISE CHEMISTRY
CBSE CHAMPION CHAPTERWISE-TOPICWISE MATHEMATICS
CBSE CHAMPION CHAPTERWISE-TOPICWISE BIOLOGY
CBSE CHAMPION CHAPTERWISE-TOPICWISE ENGLISH CORE
CBSE CHAMPION CHAPTERWISE-TOPICWISE ECONOMICS
CBSE CHAMPION CHAPTERWISE-TOPICWISE BUSINESS STUDIES
CBSE CHAMPION CHAPTERWISE-TOPICWISE ACCOUNTANCY
CBSE CHAMPION CHAPTERWISE-TOPICWISE PHYSICAL EDUCATION
CBSE CHAMPION CHAPTERWISE-TOPICWISE SCIENCE
CBSE CHAMPION CHAPTERWISE-TOPICWISE MATHEMATICS
CBSE CHAMPION CHAPTERWISE-TOPICWISE SOCIAL SCIENCE
CBSE CHAMPION CHAPTERWISE-TOPICWISE ENGLISH LANGUAGE & LITERATURE
CBSE CHAMPION CHAPTERWISE-TOPICWISE हिंदी 'ब'

CBSE CHAMPION Chapterwise-Topicwise Solved Papers Series contains topicwise questions and solutions asked over last decade in CBSE-Board examination.

Questions are supported with topicwise graphical analysis of previous years CBSE Board questions as well as comprehensive and lucid theory. The questions in each topic have been arranged in descending order as per the marks category. Questions from Delhi, All India, Foreign and Compartment papers are included. This ensures that all types of questions that are necessary for Board exam preparation have been covered.

Important feature of these books is that the solutions to all the questions have been given according to CBSE marking scheme. CBSE sample paper and practice papers are also supplemented.

Examination papers for Class-10 and 12 Boards are based on a certain pattern. To excel, studying right is therefore more important than studying hard, which is why we created this series.

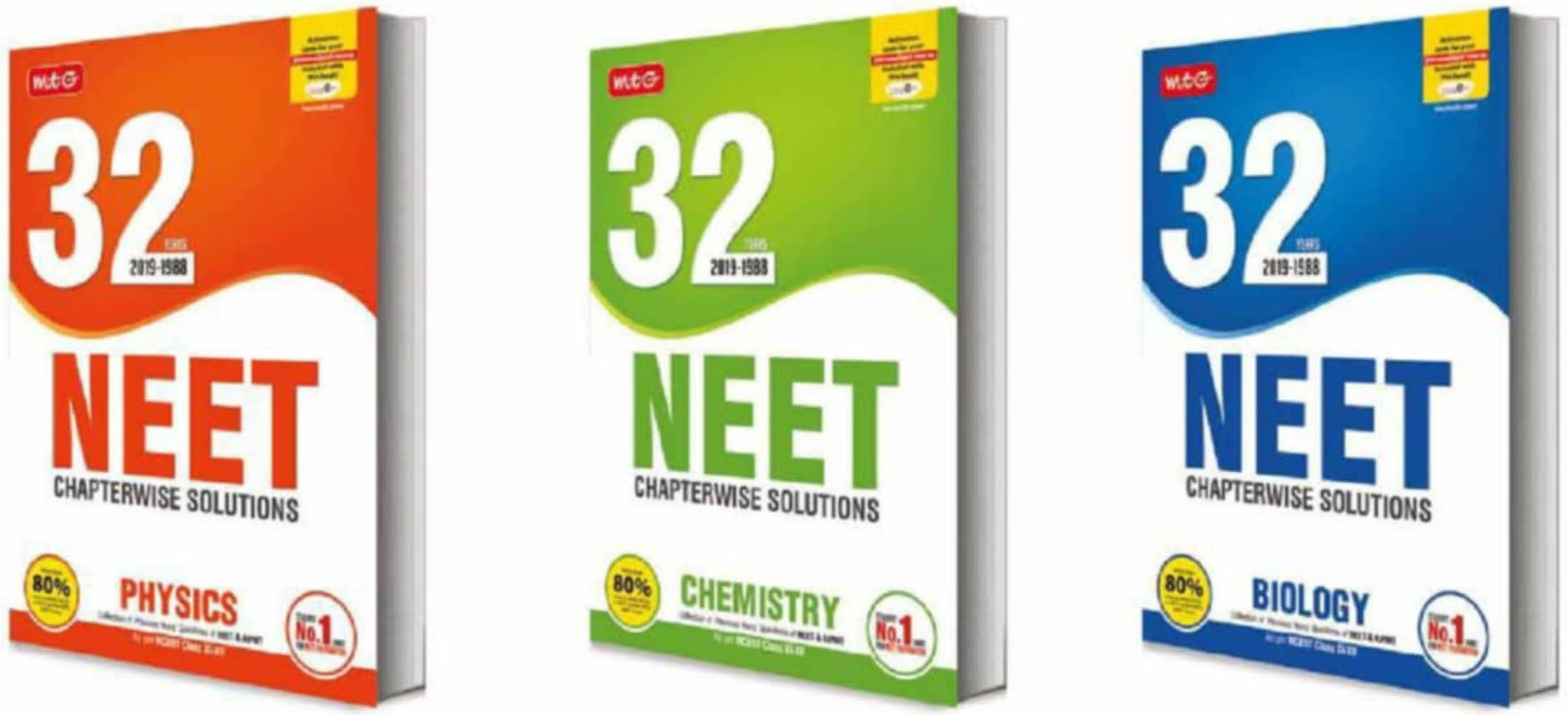
Visit www.mtg.in for latest offers and to buy online!

Available at all leading book shops throughout India.
For more information or for help in placing your order:
Call 0124-6601200 or email info@mtg.in

Registered R.N.I. No. 71810/1999 *Published on 1st of every month* Postal Regd. No. DL-SW-01/4046/18-20
Lic. No. U(SW)-32/2018-2020 to post without prepayment of postage N.D.P.S.O.N.D-1 on 1-2nd same month

mtG

The most comprehensive **question bank books** that you cannot afford to ignore



32 Years' NEET• AIPMT Physics, Chemistry & Biology contain not only chapterwise questions that have appeared over the last 32 years in NEET/AIPMT, but also full solutions, that too by experts. Needless to say, these question banks are essential for any student to compete successfully in NEET.

HIGHLIGHTS:

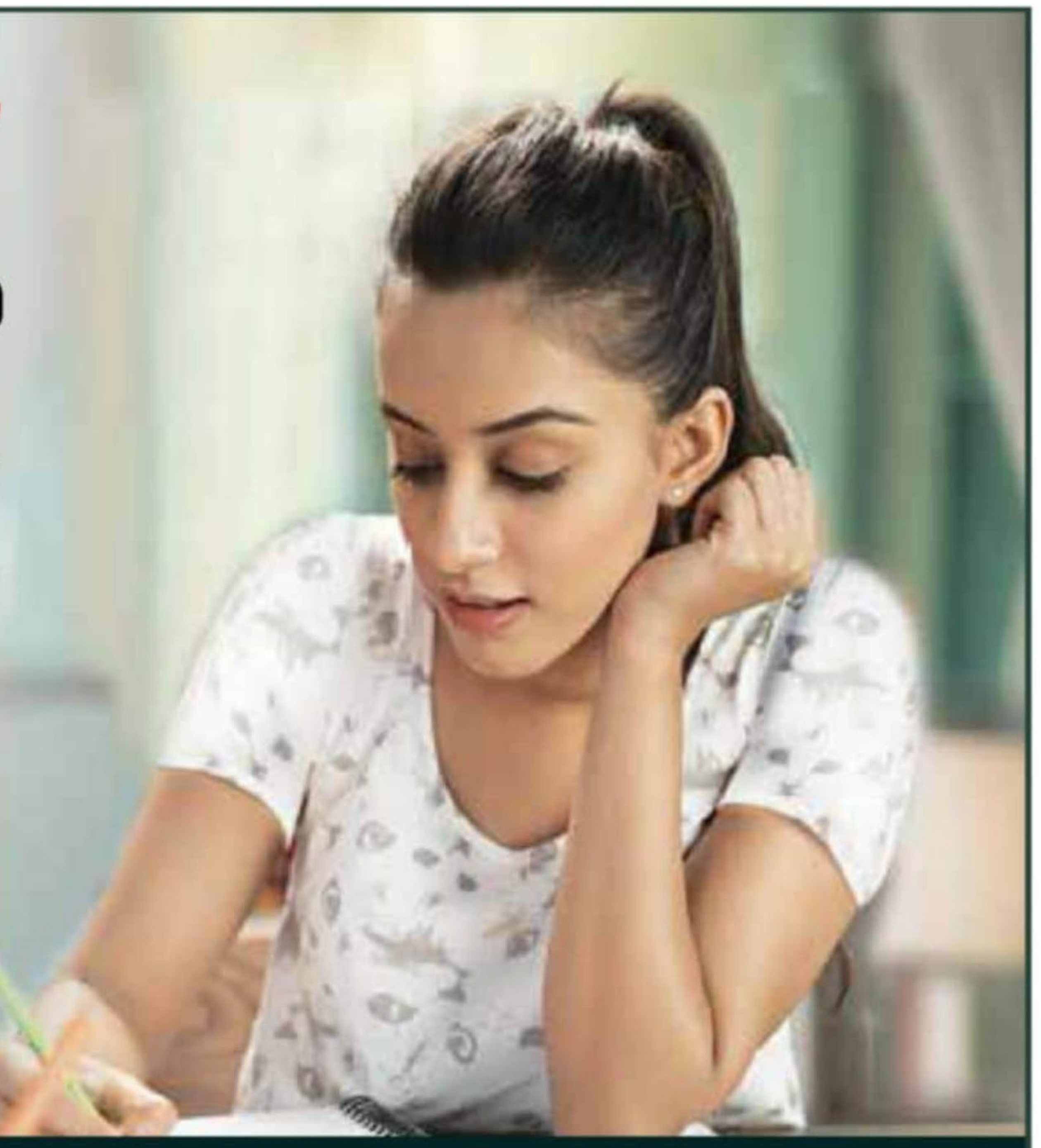
- Chapterwise questions of last 32 years' (2019-1988) of NEET/AIPMT
- Chapterwise segregation of questions to help you assess the level of effort required to succeed
- An unmatched question bank series with close to 1,000 pages having detailed solutions by experts

*Scan now with your smartphone or tablet**

mtG Learning Media

Available at all leading book shops throughout India.
For more information or for help in placing your order:
Call 0124-6601200 or email info@mtg.in
**Application to read QR codes required*

Visit www.mtg.in for latest offers and to buy online!



"Where there is a will, there is a way"

TAKE THE FIRST STEP TOWARDS YOUR DREAM ON
20th OCTOBER (SUNDAY)

Aakash National Talent Hunt Examination gives you an opportunity to realize your dream of becoming an engineer or a doctor and win scholarship up to 100%. So enroll for ANTHE and start your preparation for Engineering & Medical Entrance Exams and other Competitive Exams like NTSE, KVPY, Olympiads etc.

Aakash NATIONAL TALENT HUNT EXAM
ANTHE
—2019—

For Students Studying in Class 8th to 12th

ADVANTAGES
- SCHOLARSHIP UP TO 100%
- CASH AWARDS
- KNOW YOUR POTENTIAL AT ALL INDIA LEVEL
- OFFLINE / COMPUTER BASED TEST (CBT)
- DAILY PRACTICE TESTS FOR EXTENSIVE PREPARATION

HOW TO ENROLL
- SCAN THE QR CODE
- www.aakash.ac.in/anthe LOG ON TO OUR WEBSITE
- Google play App Store Aakash APP
- VISIT TO NEAREST AAKASH CENTRE

Exam Fee: ₹ 500/-

Last date of receiving duly filled Enrollment Form by post at Registered Office / by hand at Aakash Centre / Online Submission by 6:00 P.M. 15th October, 2019 (Tuesday)

COURSE OFFERED

CLASS 8th MOVING TO CLASS 9th	CLASS 9th MOVING TO CLASS 10th	CLASS 10th MOVING TO CLASS 11th	CLASS 11th MOVING TO CLASS 12th	CLASS 12th STUDYING STUDENTS
1, 2 & 4 Year Integrated Courses	1 & 3 Year Integrated Courses	2 Year Integrated Courses	1 Year Integrated Courses	1 Year Repeater Courses
School / Board Exams, NTSE, Olympiads, NEET & AIIMS / JEE (Main & Advanced)		NEET & AIIMS / JEE (Main & Advanced)	NEET & AIIMS / JEE (Main & Advanced)	NEET & AIIMS / JEE (Main & Advanced)

Excellent Performance by Aakashians in Medical & Engineering Entrance Exams 2019

SCAN FOR NEAREST CENTRE & CONTACT DETAILS

TOLL-FREE 1800-103-2727
Give a missed call 7303749393

Aakash
Medical | IIT-JEE | Foundations
(Divisions of Aakash Educational Services Limited)

Registered Office: Aakash Tower, 8, Pusa Road, New Delhi-110005. **Ph.:** (011) 47623456 | E-mail: reach.us@aesl.in | **SUNDAY OPEN**
www.aakash.ac.in | instagram.com/aakasheducation | facebook.com/aakasheducation | twitter.com/aakash_twitted | youtube.com/AakashEducation | aakash.ac.in/blogs